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Physiologic Specialization in Phytopathogenic Fungi
Elvin C. Stakman

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↓	↑									Total				
										Atom No.	2	8	18	32
1	0 n 1.0080	1 H 1.0080								2 He 4.003	2	2		
2	2 He	3 Li 6.940	4 Be 9.02	5 B 10.82	6 C 12.010	7 N 14.008	8 O 16.0000	9 F 19.00	10 Ne 20.183	10	2	8		
3	10 Ne	11 Na 22.997	12 Mg 24.32	13 Al 26.97	14 Si 28.06	15 P 30.98	16 S 32.06	17 Cl 35.457	18 Ar 39.944	18	2	8	8	
4	18 Ar	19 K 39.096	20 Ca 40.08	21 Sc 45.10	22 Ti 47.90	23 V 50.95	24 Cr 52.01	25 Mn 54.93	26 Fe 55.85	27 Co 58.94	28 Ni 58.69	28	2	8
		29 Cu 63.57	30 Zn 65.38	31 Ga 69.72	32 Ge 72.60	33 As 74.91	34 Se 78.96	35 Br 79.916	36 Kr 83.7	36	2	8	18	8
5	36 Kr	37 Rb 85.48	38 Sr 87.63	39 Y 88.92	40 Zr 91.22	41 Nb 92.91	42 Mo 95.95	43 Tc 99.	44 Ru 101.7	45 Rh 102.91	46 Pd 106.71	46	2	8
		47 Ag 107.880	48 Cd 112.41	49 In 114.76	50 Sn 118.70	51 Sb 121.76	52 Te 127.61	53 I 126.92	54 Xe 131.3	54	2	8	18	18
6	54 Xe	55 Cs 132.91	56 Ba 137.36	57 La 138.92	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm 144.91	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93
		68 Er 167.26	69 Tm 168.93	70 Yb 173.05	71 Lu 174.97	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59
7	86 Rn	81 Tl 204.39	82 Pb 207.2	83 Bi 209.00	84 Po 210.	85 At 211.	86 Rn 222.	87 Fr 223.	88 Ra 226.05	89 Ac 227.05	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np 237.05
		94 Pu 244.06	95 Am 243.06	96 Cm 247.07	97 Bk 247.07	98 Cf 251.08	99 Es 252.08	100 Fm 257.10	101 Md 258.10	102 No 259.10	103 Lr 262.11	104 Rf 261.10	105 Db 262.11	106 Sg 266.12
6	*58-71 Rare Earths Type 4f	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm 144.91	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.05
7	*90-103 Rare Earths Type 5f	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np 237.05	94 Pu 244.06	95 Am 243.06	96 Cm 247.07	97 Bk 247.07	98 Cf 251.08	99 Es 252.08	100 Fm 257.10	101 Md 258.10	102 No 259.10

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The Nature and Importance of Physiologic Specialization in Phytopathogenic Fungi

Elvin C. Stakman

Chief, Division of Plant Pathology and Botany, University of Minnesota,
and Agent, U. S. Department of Agriculture

PHYSIOLOGIC SPECIALIZATION IN PLANT pathogenic fungi is an old subject that is always new. It has long been known that within species of most pathogenic fungi there are many biotypes or physiologic races that differ principally or solely in physiologic rather than morphologic characters. It also has been known for about a quarter of a century that it is necessary to know the number, geographic distribution, and pathogenic potentialities of races to understand the development of epidemics and the regional and seasonal variation in the disease resistance of many crop plants. Moreover, it has become increasingly apparent that knowledge of physiologic specialization is important in formulating plant quarantine regulations and in the breeding of disease-resistant varieties. There are indications that it may be important also in the control of diseases by the use of fungicides and soil management practices.

It is not the purpose of this paper to catalogue specific facts about physiologic specialization but rather to evaluate what we know and indicate what we need to know. As practical needs must be met by special investigations in the multitudinous special cases, it seems desirable to discuss general principles.

The term physiologic race usually is used to designate intraspecific biotypes or groups of biotypes that can be distinguished by consistent behavior in pathogenicity. It is implied that races are essentially alike morphologically; but there may be some differences in morphology also, as is certainly true of haploid races within *Ustilago zeae*, which comprises sporidial, mycelial, and many intergrading types. In general, intraspecific lines are designated as physiologic races if morphologic characters are neither sufficiently great nor consistent to justify designating the lines as varieties. It is the usual practice, then, to apply the term physiologic race to lines or collections of plant pathogenic fungi if the most conspicuous or most important differences between them are in pathogenicity, even though there may be appreciable morphologic differences also.

Physiologic races may differ in growth rate, size, color, topography, and other characters of colonies on artificial

media; in sex and mutability; in nutritional and temperature requirements; in enzyme activity; in tolerance to pH concentrations, poisons, fungicides, or toxins; in ability to produce substances toxic to plants; in pathogenicity; and in many other characters. The number of races within many species, the abundant production of new ones, and the number of characters in which they may differ require many criteria for distinguishing between closely related races or sometimes even between distantly related ones.

Puccinia graminis tritici, stem rust of wheat, which is itself a variety of *P. graminis*, comprises, for example, an indefinite number of pathogenically different biotypes. Each of the 189 described races may comprise one or more of these biotypes. For practical purposes these races are identified by inoculating about 20 seedling plants of each of 12 so-called differential varieties of *Triticum* spp. These were selected as differentials a number of years ago because they seemed to be representative of several hundred varieties that had been tested for reaction to the rust races then known. But plant breeders have subsequently developed many new varieties of wheat, and consequently there are many potentially new differentials that may enable the recognition of racial differences not formerly apparent. Naturally, therefore, it is necessary to test these new varieties against available races. But not enough races are available, because the process of identification, description, and recording has been in progress for about 30 years, and some races that were common then are no longer found. Also, there can be no certainty that a rust collection that was identified as race 8 a quarter of a century ago is identical genotypically with one that is so identified today. Unless all races are maintained permanently in living condition and in pure form under standardized conditions, which is practically impossible, a collection identified as race 8 today must be compared with the record of performance of race 8 many years ago; it is a comparison with a record, not with a type specimen. Despite this difficulty, the agreement of the records often is so remarkable that doubts regarding genotypic identity seem unimportant for practical purposes.

Regardless of the inherent difficulties in identifying physiologic races of an obligate parasite like *P. graminis tritici*, relative precision can be attained. Seedlings of the 12 differential varieties are inoculated in the greenhouse with rust collections, placed in a moist chamber for 48

Vice-presidential address delivered at Boston, December 27, 1946, before Section G, AAAS.

hours, kept on a greenhouse bench; and in about two weeks, the exact time depending on light intensity and temperature, identification can be made. The degree of susceptibility of the differential varieties may range from immune to completely susceptible, corresponding with well-defined infection types ranging from 0 to 4, with a variable type X, produced by certain races on certain varieties. Infection types 0, 1, and 2 are clear-cut indications of resistance, and types 3 and 4, of susceptibility. Type X indicates a "mesothetic" or variable reaction. Races can then be identified by means of a trichotomous key based on resistance, susceptibility, or a mesothetic reaction of the differential varieties. But there are degrees of resistance and susceptibility. Thus, all of the differential varieties except Khapli emmer are susceptible to race 15, first identified more than 25 years ago. But there are degrees of susceptibility. Several years ago there was obtained from Brazil a collection to which some of the differentials were decidedly more susceptible than to one from the United States. On the other hand, several varieties were less susceptible to a collection from Japan than to that from the United States. According to the key for the determination of races, all three collections were race 15. They were, however, different, and accordingly were designated as races 15, 15A, and 15B. From a scientific standpoint it would be justifiable to designate them as distinct races; from a practical standpoint there is advantage in considering them as biotypes of the same race. Many others of the 189 numbered races are known to comprise several biotypes. In reality, then, there are many more races than the 189 that have been numbered.

It is becoming increasingly evident that *P. graminis tritici* comprises an indefinite number of biotypes that differ in pathogenicity and other physiologic characters. It is equally clear that the differences between many of them are so slight as to defy easy and certain identification by the methods that are available. Phenotypic variability sometimes may obscure genetic differences between closely related biotypes, or even between certain closely related races, in so far as genetic relationship is indicated by the reactions of the relatively few wheat varieties that can be used because of limitations of time and space. Light, temperature, varietal purity, and vegetative vigor of the inoculated wheat plants cause considerable variation in infection types. As an extreme example, certain varieties of wheat may be highly resistant to a given race at 65° F. and completely susceptible at 85°. Differences in light intensity may have almost as great an effect. Were it possible to make large numbers of precise studies at the same time, at constant temperatures and light intensities and with standardized test plants, it would be easier to recognize the multitudinous biotypes that are known to exist. But it would even be necessary to have several sets of standardized conditions, because different biotypes may behave alike under certain sets of conditions and differently under others. The best

that can be done, then, is to study large numbers of biotypes crudely and smaller numbers intensively. In identifying races for practical purposes it is necessary to lump rather than split. Although this lumping does not reveal the great complexity of biotypic components of a single variety of *P. graminis*, it does satisfy certain practical requirements in understanding and combating a destructive pathogen.

The physiologic races of *P. graminis tritici*, as the expression has been defined, can be identified with reasonable facility and certainty. Although isolations can be made from different types of pustules if two or more races occur in a mixture, still greater assurance of purity can be attained by isolating single urediospores and establishing monospore lines, which can be propagated indefinitely as dicaryotic clones. As observable mutation for pathogenicity seems to be rare in the rusts, it is not particularly difficult to maintain the essential genetic purity of lines. But this is not true of many other fungi, such as smut fungi and many of the Fungi Imperfecti.

In the smut fungi the term physiologic race is usually used to designate chlamydospore collections that are relatively consistent in pathogenicity on certain varieties of plants. The original inoculations usually are made with a considerable number of spores, and successive crops of chlamydospores are then tested to determine the consistency of their behavior. As chlamydospores are diploid, and sexual reproduction intervenes between one generation and the next, a "chlamydospore line" comprises a changing population of biotypes. The pathogenicity of lines is, however, often remarkably consistent in replicated tests in the same year and in successive years. Thus, the writer and associates several years ago inoculated several varieties of corn in the field with collections of *U. zae* from a number of different states of this country; the degree of infection, as measured particularly by size of smut galls, ranged from light to heavy. Chlamydospores produced by each collection were then inoculated into corn the next year, with almost exactly the same results. The same procedure was followed a third year, and again the results were similar to those of the first two years. Theoretically, this would not be expected, because of the opportunity for changes in biotypes within each smut collection. In this and other cases, however, it appeared that the changes were usually not great enough, within the relatively short duration of the experiments, to become perceptible on corn plants. An industrious investigator could, however, spend a lifetime in studying biotypes within any one of these collections. There would be distinct differences between many of the biotypes within each collection, but the populations of biotypes apparently retain their distinctive characters for some time when judged by their pathogenicity on corn. Further study is being made of the geographic distribution and the stability of such "chlamydospore populations."

The corn smut fungus, then, comprises an indefinite number of haploid biotypes that may differ in so many physiologic characters that they could be considered as physiologic races. Since haploid lines cannot cause infection singly, however, they are usually not so designated. But monosporidial diploid lines also can be isolated. These can propagate asexually by budding and thus maintain themselves indefinitely as saprophytes; they can also cause infection in corn, where they produce normal smut galls and chlamydospores. Diploid lines may differ decidedly in pathogenicity, and yet they are not called physiologic races. This term is usually reserved for the "chlamydospore lines."

Clearly, then, physiologic races are different in the Uredinales and Ustilaginales. In most of the rusts they are determined by the behavior of dicaryotic clones. A culture of a given race may be maintained indefinitely in the asexual uredial stage, and some homozygous ones maintain their identity through the sexual stage also. Others, however, are so heterozygous that many segregates appear even after "selfing." In the smuts, on the other hand, it is the chlamydospores, the counterpart of rust teliospores, that are used in determining races. As the dicaryophase does not produce spores, except perhaps in a few cases, it cannot be propagated in successive generations. Moreover, as this phase appears not to thrive on artificial media, there are difficulties in studying physiological characters other than pathogenicity. But the saprophytic haplophase of many smuts can be propagated on artificial media, and the physiologic characters can be studied as in bacteria or yeasts. The pathogenicity of haploid lines, however, must be studied in paired combinations. From certain crosses between monosporidial haploid lines of *U. zeae* monosporidial diploid lines can be obtained, thus making it possible to study on artificial media the haploid parental lines singly and the diploid lines derived from them; and the pathogenicity of the dicaryophase can be studied in the host plant. Thus, studies of rusts and smuts supplement each other and furnish a rather clear picture of the continually changing diversity and complexity that may exist within species.

Physiologic specialization has been studied extensively also in such taxonomically distinct plant pathogens as *Actinomyces scabies*, *Phytophthora infestans*, *P. faberi*, *Sclerotinia fructicola*, *Venturia inequalis*, *Fomes lignosus*, *F. igniarius*, *Alternaria* spp., *Colletotrichum lindemuthianum*, *Fusarium* spp., *Helminthosporium* spp., *Rhizoctonia solani*, and many others. Since all of these can be grown readily on artificial media, certain characters can be studied that cannot be studied in obligate parasites. In many of these species a wide variety of monosporous cultural races can be isolated. Some look alike but differ in pathogenicity, and others differ in appearance but are essentially the same in pathogenicity.

Helminthosporium sativum, *H. gramineum*, and

Fusarium lini illustrate especially well the fact that there may be an indefinite number of races, ranging from 0 to 100 per cent in pathogenicity for a single variety of wheat, barley, or flax, respectively. The order of pathogenicity may differ on other varieties, however, thus illustrating again the high degree of specificity between races and varieties of crop plants.

A. scabies, the organism that causes common scab of potatoes, is made up of a motley array of cultural races that may differ almost spectacularly in cultural characters. There are the usual differences in pathogenicity, with considerable specificity between races and potato varieties; but the scab organism is especially interesting because of the ability of different races to grow at different pH concentrations, as shown by Schaal. Potato scab usually is most abundant in alkaline soils, but the fact that some races of *A. scabies* can grow at a pH as low as 5.4 suggests that the situation might be reversed where such races predominate.

R. solani has a wide host range, including such important crop plants as potatoes, sugar beets, soybeans, beans, tomatoes, peas, alfalfa, clovers, cereal grains, and flax. There are numerous physiologic races, some of which seem to be generalized in pathogenicity, but apparently some of them are specific, attacking some plants heavily and others weakly. Some also produce diffusible substances that cause stunting or wilting of noninfected tomato and certain other plants, while others do not. This suggests that certain physiologic races of this and other soil fungi may differ in injurious effects on crop plants because of differences in ability to produce toxic substances that can act at a distance.

There is evidence also that races of some plant pathogens, such as *A. scabies*, may differ in their susceptibility to antibiotic organisms that are common in the soil. Extensive investigations are needed to determine whether the differential ability of different races of various pathogenic fungi to survive in the soil may be due partly to their ability or inability to compete with other soil organisms. The ability to produce substances antibiotic to other organisms and to withstand those produced by competing organisms may be important in survival and success as pathogens. The complex series of interactions between the large numbers of physiologic races of plant pathogens and nonpathogens in the soil may partly explain the variable results often obtained in pathogenicity tests in nondisinfected soils.

Physiologic races, as would be expected, differ in temperature relations. As an example, race 56 of *P. graminis tritici* is most pathogenic at fairly high temperatures, while races 34 and 36 are most pathogenic to certain varieties at lower temperatures. The effect of temperature varies with the rust race and the variety of wheat on which it is growing; hence, there may be a complex series of interrelationships.

From the foregoing it is evident that there may be a

wide range of variation in the behavior of physiologic races, especially in their pathogenicity. Environmental conditions affect the vigor of the pathogen, the resistance of the host, and the interaction between the two. Laboratory materials and procedures can be standardized; light, temperature, and humidity can be controlled only to a limited extent in the ordinary greenhouse; conditions in the field can be controlled still less; and the microflora of the soil defies standardization unless experiments are made in disinfected soil, and then the results have only limited application. But one of the most important reasons for variability is variation in the pathogen itself.

Mutation is extremely common in many fungi—probably even more common than it seems to be. Many mutants differ so slightly from their parents and other biotypes in morphologic or physiologic characters that there are difficulties of identification similar to those already discussed in connection with physiologic races. In fact, mutants often are new physiologic races, and, unless extensive comparative tests are made between closely related ones, differences do not become apparent. When effort is concentrated on the detection of certain important character differences only, others easily can be overlooked.

From long-time studies of mutation in *U. zae* it is evident that a single biotype may produce hundreds of mutants in a short time. Single, haploid sporidia can be isolated, and since they multiply rapidly by asexual budding on artificial media, many different characters can easily be studied. Some haploid lines are extremely mutable and others are very stable, with many intervening degrees of mutability. There is a wide range in the magnitude of differences between parents and mutants, involving one or more characters. Mutation in color illustrates the point. From a line whose colonies produce a deep tan color mutants can be obtained that differ only in almost imperceptible tints. Similarly, a series differing only in faint vinaceous shades and tints can be obtained. There are similar differences in sex, enzyme activity, pathogenicity, and even mutability. So, unless it is known where and how to look for differences, many will never be observed. Without taking extraordinary precautions to maintain the purity of certain monosporidial lines of *U. zae*, they may soon comprise many biotypes, some of which differ in appearance and some of which are alike in appearance but different in certain important physiologic characters that are not apparent in the mixed population of biotypes. If this is true of the haplophase of *U. zae* and other smut fungi—and it is—what is the composition of monosporous lines of *Fusarium*, *Helminthosporium*, or *Alternaria*, all of which produce multicellular spores, in some of which the individual cells are multinucleate and possibly heterocaryotic? It may be considered surprising that isolates behave as consistently as they sometimes do.

Questions regarding the importance of heterocaryosis

in the production of new biotypes and the degree of their stability cannot be answered categorically—at least not by the writer. The dicaryophase of smuts and rusts is, of course, heterocaryotic. It has been shown repeatedly that degree of pathogenicity depends on the haploid lines that were combined, just as the characters of hybrid lines of higher plants depend on the genes contributed by the parents. In the smuts and rusts this is equally true of dicaryotic hybrids, in which the two haploid nuclei of each dicaryon have different genes that are not recombined until after the termination of the dicaryophase. Such special cases of heterocaryosis furnish at least a basis for the assumption that hyphal anastomoses in some fungi may result in association of nuclei with different genes. Dickinson showed that some excised hyphal tips resulting from hyphal fusions between a red and white *Fusarium* produced pink colonies, which, however, soon dissociated into the original red and white types. Possibly the association is more permanent in some fungi. From the results of Hanson and others this seems to be true; consequently, additional doubts are created regarding the degree of genetic purity of monosporous lines of some fungi.

Physiologic races may be variable also because of semi-permanent modifications induced by certain environmental factors. It has long been the practice of the writer and his associates to grow smut lines on the same medium and under the same conditions of light and temperature before comparing them, because of an observed “hang-over” effect. Various attempts were made to find out whether monosporidial haploid lines of *U. zae* could adapt themselves to arsenic and other poisons other than by mutation. It is now certain that the tolerance to arsenic and malachite green can be increased by successive transfers, as Jollos showed for *Paramecium*. Monosporidial lines, both haploid and diploid, differ in their ability to develop tolerance; and there appears to be no correlation between the mutability of lines and their ability to develop it. Miss Hirschhorn made an intensive study of mutation in relation to this adaptation but found no evidence that mutation accounted for the results. Moreover, the “adapted” lines reverted to normal in appearance and lost their acquired ability after several transfer generations on arsenic-free media. The ability was acquired gradually and lost gradually, just as Jollos showed for *Paramecium*. On the other hand, J. J. Christensen and associates could find no evidence that *F. graminearum* adapted itself to malachite green, ethyl mercury phosphate, and certain other substances except as a result of mutation. In his experiments the parental line did not change, but many mutants—physiologic races—appeared in the cultures. Some grew about equally well as the parents on the poisons, some very much more poorly, and some very much better. The methods and objectives in the experiments with *U. zae* and *Fusarium* were essentially the same, but the

phenomena encountered appeared to be quite different. Easy generalization is about as dangerous here as in many of the other phases of physiologic specialization. How important are mutation and hybridization in plant pathology? No categorical answer can be given. It is known that new races may appear—unless the supposedly new races are in reality old ones that are reappearing—and that some become established locally or regionally and attack hitherto resistant varieties of crop plants. How many of these new races were introduced from other regions and how many resulted from mutation or hybridization is not known. It is known, however, that occasional mutants—those of *U. zeae* and *H. sativum*, for example—may be more virulent than their parents. It is also known that new races, some of which are very virulent on certain varieties of crop plants, can result from hybridization, as is clearly true of certain rusts and smuts. The investigations of Keitt and his associates indicate that this is also true of the apple scab fungus.

In the smut fungi it has been shown at Minnesota and elsewhere that there may be extensive hybridization between biotypes within species, between different species, and between different genera. There is a wide range in virulence in the races resulting from recombinations. Some appear to have only slight survival ability; others are potentially dangerous. There is no information, however, regarding the origin of the new races that have appeared to attack previously resistant varieties. Investigations of the genetics of smut fungi have shown how new races can arise but not how they have arisen. The evidence is clearer with *P. graminis*.

It is known from the results of investigations in Australia, Canada, and the United States that hybridization between varieties or races of *P. graminis* on *Berberis* spp. can result in the production of many physiologic races, old and new—at least new to science. Of course, this is to be expected, as there are more than 200 known races of the tritici variety alone. A dozen or more races can even be isolated from aecia resulting from selfing certain races. Here it is possible to find out not only what can happen but also what actually does happen in nature, principally because the sexual process is localized on barberries and there are relatively quick and easy methods of identifying the resulting races.

The fact that new or unusual races of *P. graminis tritici* are produced abundantly on barberries in nature is evident from the fact that in large numbers of identifications of rusted material collected near barberries, a different race is found in about every four or fewer collections. When collections are made at random away from barberries, however, a different race is found in about every 60 collections, the exact ratio in each case depending on the year and locality or region from which the collections are obtained. As an example, in a small barberry-infested area in the eastern part of the state of

Washington 32 races or biotypes were found near barberries from 1943 to 1946, and only 5 of these races were found in the entire United States away from barberries. Several of these isolates proved to be new races. In 1946, from 47 collections of rusted wheat in the same local area in Washington, 16 races were identified; in Virginia, 12 races were isolated from 51 similar collections. In the United States as a whole, on the other hand, 5 races made up 95 per cent of all isolates, and 4 made up 93 per cent. Many factors determine whether these new or rare races produced on barberries will become widely established. Many of them have not and may never become established; but, based on past experience, some of them may become prevalent and widespread.

Two outstanding examples of the establishment of new races of *P. graminis* illustrate what may happen. Ceres wheat, first distributed in 1926, was so resistant to stem rust that it soon became the most popular variety of spring wheat and occupied most of the acreage in the Dakotas and Minnesota and considerable acreage in Canada. In 1928 a new race of stem rust (race 56) was found in barberry areas in Iowa and Nebraska. This increased slowly in prevalence for several years. By 1934 it had become the most prevalent race, and it continued to increase in prevalence until 1938, when it comprised 66 per cent of all uredial isolates obtained from wheat. Ceres wheat was very susceptible to this race and was so severely injured in the epidemics of 1935 and 1937 that it was soon supplanted by other varieties. From 1934 to 1946, inclusive, race 56 has ranked first in prevalence in the United States every year except 1941, when it ranked second. Within 10 years this race spread over almost all of North America. The history of race 56 has been recited many times. It is, however, the outstanding example of the way in which a new race can appear and become widely destructive in a short time.

In the United States, race 8 of *P. graminis avenae*, the oat stem rust, has had a career similar to that of race 56. In 1937 it was found in barberry-infested areas of Iowa, Wisconsin, and Pennsylvania, and comprised only a very small percentage of the total number of isolates of oat stem rust in the United States. In 1938 it was found only near infected barberries in southwestern Virginia, but since that time it has extended its geographic range and increased in prevalence. In 1945 it comprised almost 50 per cent of all the isolates of oat stem rust in the United States, and in 1946 more than 50 per cent. It now is known to extend from Canada to south-central Mexico and at least from the Rocky Mountains to the Atlantic Seaboard. This race attacks heavily certain recently produced varieties of oats that were well on their way to monopolizing the oat acreage in many of the heaviest oat-producing areas of northern United States because of their resistance to stem rust and other diseases. These varieties were resistant to the races of stem rust that predominated while they were in the making, but

the increase in race 8 has exposed them to a new and dangerous biotic environment. Fortunately, still other varieties have been produced that are resistant to race 8. But race 7, which can attack some of these varieties, has been appearing in barberry areas. Whether it will ever become prevalent, as race 8 has, cannot be predicted. In the meantime, varieties are being produced which seem to be resistant to all known races, although there is some evidence that they are susceptible to certain of them at high temperatures.

Some of the best stem rust-resistant commercial varieties of spring wheats now grown in the United States are resistant to race 56 and the other races now prevalent but are susceptible to certain as yet unprev-
alent races that are found only near barberries. Crosses

now are being made in the attempt to produce varieties resistant to these races, should they duplicate the history of race 56. Moreover, it is known that there are rust races in certain other countries that are far more virulent than anything yet found in North America. Whether these will ever be produced naturally in North America, whether they will be introduced, or whether they will be carried into North America by the wind are questions that only the future can answer. Plant breeders and plant pathologists proceed on the assumption that the sort of thing that has happened in the past may happen in the future. But to prepare for the future it is necessary not only to know the physiologic races of the present but also to learn the principles basic to predictions regarding those which are potential.

The National Academy of Sciences:

Abstracts of Papers Presented at 1947 Meeting

The Sun a Regular Variable Star

C. G. Abbot

Smithsonian Institution, Washington, D. C.

The variation of values of the solar constant of radiation for the years 1924-44 reveals a regular periodicity of 6.6456 days. Statistical studies of temperature departures at Washington, D. C., St. Louis, Missouri, and Helena, Montana, show that this solar periodicity is attended by fluctuations of temperature of identical average period and an average range of 5°F. Apparently these temperature fluctuations have not hitherto been recognized as periodic because, while the solar period is invariable, its terrestrial effects are subject to phase displacements of $\pm 1, 2$, and occasionally 3 days, and the amplitudes of the temperature effects range from 2° to 20°F.

Blood Protein Studies With Labeled Elements

William F. Bale

University of Rochester, Rochester, New York

In mammals, absorption of the most essential foodstuffs from the gastrointestinal tract is indiscriminate; it does not depend on whether or not the body is already liberally supplied with this substance. The disposal of surplus amounts is through degradation and excretion.

The metabolism of iron has been found not to follow this general rule. Hemoglobin, the iron-containing red protein of the blood erythrocyte, is the primary means of oxygen transport in mammals. Iron is thus essential to mammalian life. Early studies with radioactive iron show that in this case the body excretes surplus iron only in negligible amounts. Instead, normal dogs and humans absorb iron from the gastrointestinal tract when needed and, when the need is satisfied, allow the

iron to pass unabsorbed into the feces. Further experiment with radioactive iron, carried out by research groups at Rochester and at Berkeley, indicate that even sterile infections, such as abscesses induced by turpentine injections, prevent iron absorption in animals anemic through blood loss and needing iron. Also, such infections prevent hemoglobin formation even from injected iron.

An average life span of 120 days for the dog erythrocyte is indicated from studies on excretion of porphyrin breakdown products by Hawkins and Whipple. Studies with radioactive iron aimed at confirming this life-span figure failed to give adequate data for this purpose for an unexpected reason: it was found that the dog utilizes almost exclusively the iron liberated from his own worn-out red cells for building new ones, even with very large stores of other reserve iron in his body.

Later, Shemin and Rittenberg showed, by the use of the distinctive heavy isotope of nitrogen, that glycine nitrogen is the source of the porphyrin nitrogen of the hemoglobin. In subsequent experiments, in which such a labeled glycine was fed to a human subject and then the rate of disappearance of the resulting labeled hemoglobin followed, they have shown that the average life span of the human red cell is also about 120 days.

Distinctive isotopes, radioactive and stable, are also of proven value in investigations of blood-plasma proteins. Originally, it was supposed that in addition to forming a blood clot following injury, their function was principally that of maintaining the osmotic pressure of the blood and thus preventing plasma loss into the intercellular tissue spaces. Later, vital immunological functions were definitely attributed to certain of these proteins.

In 1938, Howland and Hawkins showed that injected plasma protein can be used by dogs for other nutritional purposes,

apparently without ever passing through an amino acid stage in the plasma. This indication that the plasma proteins may be important intermediaries in protein metabolism receives added support from work by Schoenheimer and his associates at Columbia University. From their data they suggest an average half-life of about two weeks for plasma protein molecules. Work carried out at Rochester in which tagged plasma proteins synthesized in one dog were reinjected into a second animal suggests an even shorter lifetime in the blood stream for the average plasma protein molecule. They find 50 per cent of the labeled material gone from the plasma in 30 hours and 75 per cent gone in 6 days.

Tarver and Reinhardt have recently carried out plasma protein studies which strikingly indicate the importance of the liver as a site of plasma protein production. When methionine, labeled with radioactive sulfur, is administered to completely hepatectomized dogs, they find that plasma globulin synthesis is depressed to $\frac{1}{4}$ of normal and albumin synthesis to below $\frac{1}{10}$ of the normal value.

Such results point out that one of the particularly valuable uses of labeled isotopes depends upon their ability in many short-term, acute studies to give valid data concerning the quantitative aspects of physiological functions. Such results also suggest that, through the use of suitable labeled amino acids, it will be possible to measure the efficiency of the human liver in synthesizing plasma proteins in health and disease.

Ovular Tumors Associated With Hybrid Embryos in *Datura*

Albert F. Blakeslee and Sophie Satina

Genetics Experiment Station
Smith College, Northampton, Massachusetts

It has been shown by one of us (S.) that, following pollination of *D. stramonium* by a distinctly related species, *D. Metel*, hybridization takes place freely, but the hybrid proembryos abort usually at or before the 8-cell stage, accompanied by an enlargement and proliferation of the cells (endothelium) immediately surrounding the embryo sac. Such proliferating cells may invade the embryo sac and form ovular tumors or "pseudo-embryos." Similar abnormal growth has been found in other wide crosses. Ovular tumors are also the rule from the cross $4n \times 2n$ as well as from the reciprocal cross $2n \times 4n$ when both parents belong to the same inbred line of *D. stramonium*. The fact that van Overbeek and Conklin have induced such ovular tumors in *Datura* by injection of auxins indicates connection with chemical changes in their microenvironment and suggests the possibility of a further analysis of the factors in microenvironment responsible for differentiation in normal development as well as for abnormal growth with hope of their ultimate control.

The Surgical Treatment of Congenital Pulmonic Stenosis

Alfred Blalock

Johns Hopkins Hospital, Baltimore, Maryland

Congenital defects of the heart and the great arteries arising from the heart are not uncommon. There was no satisfactory surgical treatment for any of these prior to 1938. Since that

time, advances have been made in the surgical therapy of three of the most common types, namely, patent ductus arteriosus, coarctation of the aorta, and pulmonic stenosis. Methods for treating some of the other deformities will probably be developed.

This presentation will be limited to a consideration of the treatment of pulmonic stenosis, which is a constricting deformity of the main artery to the lungs at the point where it arises from the heart. This deformity is usually associated with additional defects in the heart, but the major disturbances are caused by the pulmonic stenosis. Patients with this deformity are cyanotic and are commonly called "blue babies." More important than the color change is the fact that the patients have definite restriction in their physical activities. The red blood cell count is greatly increased, and the oxygen saturation of the arterial blood is greatly decreased. As stated previously, the major factor responsible for these findings is an inadequate flow of blood through the lungs as a result of the pulmonic stenosis. Oxygen is available in the lungs, but the flow of blood to the lungs is so reduced that an adequate quantity of oxygen is not delivered to the body.

The operation which has been developed for the treatment of these cyanotic patients is a shunt or by-pass procedure and consists in the making of an anastomosis between a large branch of the aorta and the pulmonary artery distal to the point of stenosis. Fortunately, the pulmonary artery is usually essentially normal except for the stenotic area. Following the establishment of this artificial communication, the high pressure in the aorta causes a large quantity of inadequately oxygenated blood to flow through the pulmonary artery and the lungs, and this blood returns to the heart with a high degree of oxygen saturation.

During the past 30 months 375 cyanotic patients who were diagnosed as having pulmonic stenosis (the tetralogy of Fallot) by Dr. Taussig and her associates have been operated upon in the Johns Hopkins Hospital. The ages have ranged from 4 months to 26 years. The over-all mortality rate has been approximately 17 per cent. Most of the patients who have survived the operation are strikingly improved. In many of these the cyanosis and the clubbing of the fingers and toes have disappeared, the red blood cell count has declined to normal, and the oxygen saturation of arterial blood has increased greatly. Some of the patients who could walk only a few feet before operation can now walk miles.

Relativistic Correction to the Magnetic Moment of the Deuteron

G. Breit and I. Bloch

Yale University, New Haven, Connecticut

The corrections referred to are considered for a proton and neutron moving in each other's field. Two alternative equations are used as starting points for the calculations. One of these is an extension of the electrodynamic laws of interaction between charged particles; the other is typical of Hamiltonians giving rise to inverted (Thomas term-like) vector spin orbit doublets and is an extension of the scalar field one-body equation. The calculations reported on here show about the same degree of sensitivity of the relativistic correction of the deuteron's moment to the type of interaction assumed between particles as has been obtained previously

(G. Breit. *Phys. Rev.*, 1947, 71, April 15) in simplified considerations with a single particle model. It is concluded, therefore, that one cannot be sure of estimates of relativistic corrections to approximately their whole magnitude and that even the sign of the correction cannot be considered as certain. Considerations regarding additivity of nuclear moments involving an accuracy of much better than .01 nuclear Bohr magneton appear to be obscured not only by the presence of relativistic corrections but also by the remoteness of sufficient knowledge concerning the interactions between particles which is essential for the determination of the effects of relativity.

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The Physical Basis for the Use of Isotope Tracers in Biology and Medicine

Dean Cowie

Department of Terrestrial Magnetism
Carnegie Institution of Washington, Washington, D. C.

Some of the characteristics of radioactive isotopes which make their use so valuable in biological research are discussed. These include the ease of detection of extremely small quantities of certain of the isotopes, the rapidity of scanning a large number of samples for qualitative measurements, and the ability to trace a particular element (once tagged by being made radioactive) in the presence of large amounts of that same element. Certain limiting characteristics such as half-life, energy of the emitted particles, low specific activity, and physiological changes produced by the radiation of the labeled substances are presented. The stable isotopes are also considered in a similar manner, the extremely valuable characteristics as well as the limitations being given.

Production of Mutations in *Drosophila* by Treatment With Some Carcinogens

M. Demerec

Department of Genetics, Carnegie Institution of Washington
Cold Spring Harbor, New York

Males of *Drosophila melanogaster* have a large supply of mature sperm in their testes. A method has been developed for treating these males with various chemicals by keeping them in an atmosphere containing an aerosol of a solution of the desired chemical. It has been found that by means of such treatment the sperm in the testes of exposed males may be reached and genetic changes in the sperm produced.

After the effect of aerosols of 19 chemicals had been tested without any detectable genetic change in the sperm, an aqueous aerosol of a nitrogen mustard—methyl-bis(β -chloroethyl)amine—was tried, because Auerbach and Robson had induced mutations by exposing *Drosophila* males to a vapor of that mustard. Results of the treatment with mustard aerosol were positive. Both mutations and chromosomal rearrangements were obtained. These results proved the effectiveness of the aerosol method.

Subsequent experiments with aerosols of four carcinogens (1,2,5,6-dibenzanthracene, methyl cholanthrene, benzpyrene,

and β -naphthylamine) gave positive results. Experiments with dibenzanthracene have progressed far enough to show that this chemical induces both gene changes and breaks in chromosomes. The gene mutations are not specific. Analysis indicates that the affected genes are distributed at random along the X chromosome. The genetic effect of dibenzanthracene is very similar to the genetic effects induced by radiations (X-rays, ultraviolet, neutrons).

Up to the present time, mutations have been induced experimentally by radiations, mustards, and the four chemicals mentioned here. All known mutagenic agents that have been adequately tested are also carcinogenic. This close correlation between carcinogenicity and mutagenicity gives experimental support to the hypothesis that cancer may originate as a result of a mutation occurring in a somatic cell.

Solar Effects in Cosmic Rays

Scott E. Forbush

(Introduced by M. A. Tuve)

Department of Terrestrial Magnetism
Carnegie Institution of Washington, Washington, D. C.

During the past 10 years three unusual and sudden increases in cosmic ray intensity, lasting several hours, have been observed simultaneously in different parts of the world, except at the equator, where no increase was observed. All three increases began nearly simultaneously with unusually long and intense radio fadeouts and solar flares and were similar and simultaneous on the day and night sides of the earth. Magnetograms from several magnetic observatories indicate that the increase in cosmic ray intensity cannot be ascribed to changes in the earth's magnetic field. While such increases might be ascribed to changes in the sun's general magnetic field, which would permit more cosmic rays from outer space to reach the earth, such a mechanism should be equally effective whether the solar flare occurred on the front or back side of the sun. This, with other arguments, indicates that changing magnetic fields associated with a sunspot or flare may act as a magnetic accelerator for charged particles. Similar processes on stars might account for all cosmic rays.

Beneficial Mutations in Laboratory Strains of *Drosophila*

Th. Dobzhansky and B. Spassky

Columbia University, New York City

Experimentally observed mutations are deleterious or, at best, neutral to their carriers. This seems to contradict the view that the process of mutation supplies the raw materials from which evolutionary changes are compounded. The contradiction is, however, spurious. Any mutation found in experiments has, presumably, arisen many times in the history of the species. A mutation that furthered the adaptation of a species to its normal habitat would have been selected and established as the "normal" or wild-type condition. To detect beneficial mutations, strains that carry deleterious genetic variants, which reduce the viability below normal, must be chosen as initial materials; in such strains, mutations that cancel the deleterious effects and bring the vigor and vitality back to normal may be expected to occur. This expectation has

been tested by observing the behavior of 7 strains of *Drosophila pseudoobscura* for 50 generations. The initial 7 strains were known to be homozygous for certain second or fourth chromosomes that reduced either the viability of the flies or their development rate, or both. The strains were kept in overpopulated cultures at 21°C. for 25 generations, and at 25½°C. for the following 25 generations. In one subline of each strain the male parents were given a treatment of 1,000 r-units of X-ray in each generation; the second subline was untreated. To test the changes in the viability and development rates, 410,784 flies were classified and counted. Improvements of the viability were observed in 5 of the untreated and in 6 of the X-ray-treated lines; in some of these lines, the improvements were quite striking. Speeding up of development rates was also observed in several strains. The behavior of the X-rayed and the untreated lines was, on the whole, similar, although irradiation is known to have induced many deleterious changes; such changes were eliminated by natural selection.

Studies on the Permeability of Mammalian Membranes

Louis B. Flexner

Department of Embryology
Carnegie Institution of Washington, Baltimore,
Maryland

The vascular system and placenta are discussed as examples of those membranes of mammals which have been studied in this laboratory by means of radioactive and stable isotopes.

When water tagged with heavy water, sodium, or chloride, each labeled with one of its radioactive isotopes, is injected intravenously into the guinea pig, the concentration of the labeled substance rapidly decreases in the blood plasma and is at equilibrium in less than 10 minutes. The loss of labeled substance with time follows a rather regular curve from animal to animal. This curve is fitted by a single exponential from which the normally occurring rate of loss of the water, sodium, and chloride of the plasma can readily be determined. We have been surprised by the extraordinarily rapid rate at which the water, chloride, and sodium of the plasma are exchanged through the walls of the blood vessels with water, chloride, and sodium of extravascular fluids. Water of plasma is exchanged at the rate of 140 per cent/minute; chloride, at the rate of 128 per cent/minute; and sodium, at the rate of 60 per cent/minute. From these values it is evident that the walls of the blood vessels are 2.3 times as permeable to water as to sodium and 2.1 times as permeable to chloride as to sodium.

The permeability of the placenta, *i.e.* the rate at which a substance reaches the embryo from the maternal blood stream across a unit weight of placenta, has been studied with heavy water and radioactive isotopes of sodium and phosphorus. The permeability increases markedly as pregnancy proceeds. In man, for example, the permeability to sodium increases about 70 times from the 9th to the 36th week of gestation. A reasonable explanation of this increase is to be found in changes in the microscopic anatomy of the placenta. The placenta of the guinea pig is about 10 times as permeable to water as to sodium and about twice as permeable to inorganic phosphate as to sodium. The embryo receives, on the average,

about 300 times as much water across the placenta from the mother as is retained in its growth and about 50 times as much sodium, whereas the inorganic phosphate supplies little more than meets its needs.

It is to be remarked that observations of this kind could hardly have been made in any other way than by the use of the isotope technique.

A New Structure for Soap Micelles and the Polymerization of Rubber

William D. Harkins

University of Chicago, Chicago, Illinois

Solutions of soaps and other detergents have many remarkable properties which have been utilized in manifold ways, from the killing of bacteria to the preparation of fabrics and to cleansing. Several of these properties are of fundamental importance in the emulsion polymerization of rubber and other polymers in which aggregates of soap molecules known as micelles play a most important role. The size of these aggregates is not definitely known and has been the subject of much discussion for many years. For example, McBain considers that there are two types of micelles in aqueous solutions: (1) a small, spherical aggregate which is highly ionized, and (2) a "great," or lamellar, micelle which consists of a pile of double layers of soap. Recently, in the laboratory, R. W. Mattoon and R. S. Stearns have measured the thickness of soap micelles by a newly discovered X-ray band, and this, together with certain theoretical considerations, leads to the following picture:

A moderate number of soap molecules, possibly 100-200, at a certain definite, or critical, soap concentration, collect together in order to escape as much as possible from the water and yet remain inside it. In the case of an ordinary soap, the negative ions—for example, $C_{12}H_{27}COO^-$, if it is a myristate, consisting of the long paraffin chain $C_{13}H_{27}$ and the polar group COO^- —aggregate with the hydrocarbon chains lined up against each other in a double ionic layer. The polar COO^- groups turn toward the water and the hydrocarbon chains toward each other to make a double layer of soap molecules, which, with this particular soap, has a thickness, as determined by X-rays, of about 45 Å.—twice the length of a molecule of potassium myristate. These micelles, or double layers of soap, possess the remarkable property that they dissolve excessively thin layers of oil from 6 to 15 Å. thick between the ends of their hydrocarbon chains. In the synthesis of rubber this layer of oil consists of 25 per cent of styrene and 75 per cent of butadiene.

Thus, there is formed a two-dimensional solution which, for its third dimension, gives a thickness of only 15 Å. This, under the action of a catalyst, polymerizes and gives rise to molecules of rubber. In cleansing the skin, a similar two-dimensional solution is formed from the oils of the skin. Part of the cleansing action of a soap is due to this property, known as solubilization, although much of it is due to the emulsifying action of the soap.

Recently, in work by M. L. Corrin, a new rapid and powerful method has been discovered for the emulsion of the critical concentration at which soap micelles aggregate. By the use of this method it has been found that in their formation the general principles involved in the behavior of aqueous solutions

of ordinary electrolytes, such as the principle of ionic strength and the Debye-Hückel relations, are entirely invalid. By the uses of changes in fluorescence of certain dyes it is found possible to determine the concentration of free soap in rubber latex, a quantity which is intimately related to the rate at which the polymerization of rubber and other polymers occurs.

Other interesting relations are involved.

The Use of Isotopic Carbon in Metabolism Studies

A. Baird Hastings

Harvard University Medical School
Boston, Massachusetts

A brief résumé on the use of isotopic carbon in the study of reactions involved in the conversion of lactic acid to glycogen is given and the role played by CO_2 in the reactions discussed. A method for producing glycogen *in vitro* and the preliminary results obtained from the use of the long-life carbon isotope, C^{14} , are presented.

Forces Between Polyatomic Molecules

J. H. Hildebrand

University of California, Berkeley

A number of the properties of liquids and solutions composed of nonpolar, polyatomic molecules obey rather well certain equations derived by the aid of models with spherical molecules and radical force fields; nevertheless, the volatility of species such as OsO_4 , UF_6 , and $\text{Ni}(\text{CO})_4$ indicates that the buried atoms contribute but little to the molecular field and suggests that the peripheral atoms might well be considered as the main centers of attraction. This is tested by comparing the entropies of vaporization of liquids whose molecules differ considerably in size but whose peripheral atoms are identical. Pitzer has shown that two liquids should have the same entropy of vaporization when compared at temperatures where they have the same ratio of vapor to liquid volume, provided, among other things, that they have the same type of radial force field, as is the case with the rare gases. An approach free from this restriction leads to equality when the free volume in the liquid is substituted for the total liquid volume. Comparing in both ways chlorine with carbon tetrachloride and ethane with diisopropyl, the results are in favor of the non-radial field.

Modern Processes of Color Photography

C. E. Kenneth Mees

Vice-President in Charge of Research
Eastman Kodak Company, Rochester, New York

Photography in natural colors is not new, but until recently the processes by which color photographs could be made were difficult to practice, and their use was restricted, therefore, to a small number of experts. In all processes of color photography, three separate photographic images are recorded, each being formed by the light of approximately one-third of the visible spectrum, *i.e.* by red light, green light, and blue-violet

light. These three recorded images are then reproduced as colored images formed in dyes, the image recorded by red light being printed in blue-green, that recorded by green light in magenta, and that recorded by blue-violet light in yellow dye.

Modern processes of color photography depend upon the use of films coated with three superposed photographic emulsions sensitive to the three colors by which the images are recorded. In processing, the three images are transformed into the three required dye images, and a direct color photograph results. This method of color photography was suggested about 40 years ago, but it was not until 1935 that it could be realized in practice, the first color film of this type being a 16-mm. motion-picture film for use by amateurs. This first film was soon followed by others suitable for use in amateur photography and for commercial photographs from which color pictures could be printed. Today almost all fields of photography employ the multilayer films.

The dyes that produce the color images either may be supplied from the processing solutions, in which case the processing must be done under rigid laboratory control, or couplers to form the dyes may be incorporated in the coated layers of the film, which can then be processed by a much simpler method. The films may be developed by reversal to give positive transparencies in color, or they may be developed to negatives from which color prints on paper may be made.

Algebraic Orthogonal Curves

Edward Kasner

Department of Mathematics
Columbia University, New York City

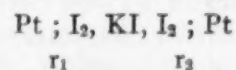
Three kinds of orthogonality for two algebraic curves in the plane are studied: (1) simple or *weak orthogonality*, where the curves are orthogonal at one point; (2) complete or *strong orthogonality*, where they are orthogonal at all points of intersection; and (3) *total orthogonality*, where the related families $\phi = a$, $\psi = b$ form an orthogonal network. Relation to hydrodynamics and function theory is discussed.

The Effect of Centrifugal Force on the EMF of Galvanic Cells

D. A. MacInnes and B. Roger Ray

Rockefeller Institute for Medical Research
New York City

When a simple galvanic cell of the type



is placed in a centrifugal field, with the electrodes at radii, r_1 and r_2 , the resulting potentials, E , are given by the thermodynamic equation

$$EF = 2\pi^2 n^2 (r_1^2 - r_2^2) [t_K(M_{KI} - \bar{V}_{KI}\rho) - (M_I - \bar{V}_I\rho)]$$

in which F is the faraday; n^2 , the rotational speed; t_K , the transference number of the positive ion constituent; M_{KI} and M_I , molecular weights; \bar{V}_{KI} and \bar{V}_I , partial molal volumes; and ρ , the density of the solution. The measurements may be used to determine transference numbers and, it is expected, be useful for determinations in which other methods have failed, since the electrodes do not have to carry appreciable current. Early work on the method was carried out by T. des

Coudres (*Ann. Phys. Chem.*, 1893, 49, 284) and R. C. Tolman (*Proc. Amer. Acad.*, 1910, 46, 109).

To develop the method to yield accurate results it has been necessary to recognize and eliminate sources of error. The chief of these were found to be (a) oxygen in the solution and surroundings of the cell; (b) the colloidal particles in the solution which are thrown to one or both of the electrodes; and (c) temperature gradients in the cell.

The first of these errors has been eliminated by replacing the oxygen with nitrogen; the second, by ultrafiltration; and the third, mainly by causing the rotor to operate in a vacuum. High precision in the measurement and control of the speed has been attained.

Topological Methods in the Theory of Functions of a Complex Variable

Marston Morse

Institute for Advanced Study
Princeton, New Jersey

The study of harmonic functions $u(x,y)$ by the method of investigation of the singularities of the level lines of $u(x,y)$ can be extended to that class of functions which are termed pseudo harmonic and which are obtained from harmonic functions by a local 1-1 deformation of the (x,y) plane near any given point. This theory, carried over to the theory of functions $f(z)$ of a single complex variable, permits the discovery of new theorems connecting the count of zeros, poles, and branch point antecedents of f in terms of topological characteristics of the boundary values of f .

Geographical Aspects of the Epidemiology of Poliomyelitis

John R. Paul

Yale University School of Medicine
New Haven, Connecticut

During the recent war years there have been opportunities for the epidemiological study of poliomyelitis as it has affected American soldiers and native populations in various parts of the world, such as North Africa, the Middle East, and the Far East. From this experience it appears that in certain countries where poliomyelitis had previously been regarded as uncommon, the disease was actually acquired by American troops at a far higher rate than at home. In most of these areas sanitation is primitive. Investigation of the areas has revealed that epidemics of poliomyelitis in the native population have been seldom recorded, although the prevalence of sporadic cases may not be particularly uncommon.

In areas such as the Middle East and Japan, where the disease is endemic, clinical aspects of poliomyelitis differ from those seen in the United States; a much younger age group is involved, and native adult cases are almost unknown. In other

words, endemic poliomyelitis, as seen among natives in these areas, is comparable to the clinical disease as it existed in Europe, Scandinavia, and the United States prior to 1880.

Strains of poliomyelitis virus collected in North Africa, the Middle East, the Philippines, China, and Japan do not appear to be different from those isolated in the United States, although no adequate immunologic comparisons have been made.

Dielectric Heating

J. B. Whitehead

School of Engineering
The Johns Hopkins University, Baltimore, Maryland

In the applications of dielectric heating to various industrial processes, alternating frequencies between 1 and 30 megacycles, and rates of temperature rise of 50° F. and upward, are common. The properties of dielectric materials vary widely under these conditions, as must also the magnitude and character of the load on the source of high-frequency power. Methods so far proposed for the measurement of dielectric properties at high frequencies are commonly restricted to low electric stresses and constant temperature, and so are not available for a rapid heating cycle. The present paper describes a calorimetric substitution method for the measurement of power, dielectric constant, loss and power factors over the heating cycles of a well-known industrial process. Interesting variations of dielectric properties are revealed.

The Use of C^{13} and C^{14} in Studying Metabolism in Animals

D. Wright Wilson

University of Pennsylvania, Philadelphia

Some experiments of our own and others, involving the use of the carbon isotopes C^{13} and C^{14} in aiding to unravel details of fat and uric acid metabolism, are discussed. The theory of beta oxidation of long-chain fatty acids with recombination of the two carbon units to form acetoacetic acid (in liver) is believed to be proved.

Acetate and acetoacetate, products of fat metabolism, were found to be oxidized via the tricarboxylic acid cycle by which carbohydrates are oxidized.

Isotopic lactate, when fed to a phlorhizinized rat, caused a great increase in excretion of glucose although it contributed only a small part of its isotope. Ten per cent of the isotope of the lactate was found in the ketone bodies. Lactate had been changed to ketone bodies without first becoming fat.

Thus, we have shown how both fat and carbohydrate material can enter the metabolic pathways of each other.

Uric acid in pigeons has been shown to be formed from small units, one carbon being furnished by $NaHCO_3$, two others by the carboxyl group of acetic acid or formic acid, and two others by glycine.



Obituary

Willard Lee Valentine

1904-1947

Willard Valentine, eminent psychologist and editor of *Science* since January 1, 1946, died suddenly of a heart attack at his home in Alexandria, Virginia, on Saturday, April 5, 1947. The loss of this able and enthusiastic leader at the age of 42 is tragic. His 17 months of devoted service to the American Association for the Advancement of Science had resulted in noteworthy contributions to the

is second to none as a factor of importance for human welfare. He entered on his new task with eagerness. His ideas were creative and vigorous; he had imagination but was willing to listen to advice and able to avoid being distraught by conflicting opinions. In November and December 1945 he made a thorough study of *Science* as a publication, analyzing its history and achievements and then formulating policies and goals in line with those of the Association. The main objective chosen was to make the journal maximally useful to American scientists and



growth and influence of the Association. This brief period seemed to herald great accomplishments for the anticipated full span of years ahead—accomplishments that others must now strive to realize.

In the fall of 1945, Dr. Valentine resigned his professorship and chairmanship of the Department of Psychology at Northwestern University to undertake full-time service as editor of *Science*. He came to this new position with the conviction that the field of scientific publication

the general public interested in scientific news and advance. The publication was given a more attractive and dignified appearance by discontinuing advertising on the front cover, using more modern type and format, and by rearranging and adapting the magazine sections in line with current interests of the science reading public. The new editor attempted to discourage a content and style which would appeal chiefly to the specialist and endeavored to give preference to papers that presented

evidence of a cooperative attack on some scientific problem common to, or approached through, several specialties.

Valentine was not an armchair scientist nor was he an armchair editor. He undertook the editorship of *Science* as he had pursued science itself—as an experimental program. He had faith that through carefully planned and controlled trials of publishing different kinds of materials in different kinds of ways and by following through with analysis of reader reactions, a scientific basis would be discovered on which sound and creative publication policy could be built and public welfare served.

Three Middle West educational institutions gave Dr. Valentine his scientific training and teaching opportunities. He was born in Chillicothe, Ohio, December 2, 1904. His father was a flour miller, a veteran of the Spanish-American War, following which he was an invalid or at least not a man of robust health for the remainder of his life. It is recalled that Valentine referred to his mother as the chief source of his intellectual and educational stimulation. He entered Ohio Wesleyan University in 1921, receiving the A.B. degree in 1925 and the M.A. degree in 1926. He was assistant in psychology and mathematics, 1925–26, and assistant instructor in psychology, 1926–28, when he received appointment at the same rank at Ohio State University, where he earned his Ph.D. in psychology in 1929. He became assistant professor of psychology at Ohio State in 1929, was promoted to the grade of associate professor in 1932, and continued at this academic rank until 1940, when he became professor and chairman of the Department of Psychology at Northwestern University. During the 11 years following his doctorate at Ohio State, Valentine played a special role in the Department of Psychology as supervisor of beginning courses. Interest in science instruction at the undergraduate level became for him a prevailing passion which greatly influenced his professional career.

His research activities began in 1927 with perceptual studies in audition and vision, conducted on both human and animal subjects. These were excellent pieces of basic scientific work—perhaps his best. His dissertation was prosecuted under the guidance of Floyd C. Dockeray and the late Albert Paul Weiss. The former had been his professor, guide, and mentor at Ohio Wesleyan University. The dissertation, published as a series of three articles entitled “A Study of Learning Curves,” presented a large mass of data on maze learning in rats of all ages and was a very comprehensive treatment of maturation in the rat from the standpoint of learning.

A third phase of his research work, and perhaps the most productive one in stimulating later investigation, related to the study of motility in the newborn infant. Dockeray and Valentine collaborated in the development and refinement of an isolation cabinet for infant research.

Dr. Weiss had built the first such box, which served as the starting point for this work. With the fully developed equipment a considerable amount of research work was done at Ohio State by a number of graduate students, and the development of this type of investigation did much to advance scientific study of infant behavior.

Valentine's interest in applied psychology came to overshadow his earlier interest in basic research. Effective teaching of science as represented in the teaching of psychology was the objective of this applied interest. With his associate, Dr. Dockeray, he undertook a detailed analysis of the elementary psychology course at Ohio State. The objectives of the course were stated as a series of achievements which could be expected to result from taking the course—achievements such as acquisition of a body of facts and principles of human behavior, understanding of the application of psychological principles to the contacts and problems of daily life, acquisition of a technical vocabulary, development of skills in the application of scientific methods to the problems of human behavior, and the elimination of superstition and misconception concerning human behavior. By means of various examination techniques the extent to which the course was achieving the desired results was thoroughly analyzed. Examination methods were found to warrant careful study. In collaboration with F. E. Wenrick a paper on “Validity of Examinations” was published (1935) which proposed that factual examinations were inadequate.

Several supplementary lines of investigation and development were engaged in by Valentine in his systematic efforts to improve the efficiency of science teaching. He made studies of misconceptions—physical, biological, social, economic, and psychological—held by college students and examined the effectiveness of college courses in correcting these superstitions. For several years he was chairman of the Committee on Motion Picture Films for Teaching, of the American Psychological Association. He surveyed the colleges and universities of the United States in reference to their use and need for teaching films, helped to write a detailed technical guide on the production of films, and either prepared or was a collaborator in making 11 such teaching instruments. These were described in the psychological literature and made available for all who wished to purchase them. Valentine's first film, entitled “A Trip Through a Psychological Laboratory,” presented an integrated series of experiments and demonstrations highly useful for instruction in a beginning course. His *Laboratory manual for psychology* appeared in 1929 and was revised in 1932; *Readings in experimental psychology* was published in 1931; with Taylor, Baker, and Stanton he brought out *Students' guide for beginning the study of psychology* in 1935 and revised it in 1940. Valentine's most important book, *Experimental foundations in general psychology*, was published in 1938 and revised in 1941. In this volume

he presented some 19 areas of psychological interest, discussed the research findings in each, and interpreted these findings with emphasis on method and controls as well as on results. Almost 100 selected experimental investigations were thus taken up and reviewed. By this type of treatment he sought to emphasize in the mind of the beginning student that science (psychology) was grounded in, and grew out of, research work.

In 1940, when Northwestern University chose a new head for their large Department of Psychology, Valentine was the person selected. Enumeration of the reasons for his selection provides us with a block diagram of Valentine's professional contributions in the field of science. He was chosen head at Northwestern because of his emphasis on research as the foundation of science, his achievements at Ohio State in the improvement of the teaching of psychology, his professional interest in psychological publications, and finally, his demonstrated abilities as business manager and treasurer of the American Psychological Association. The first major task undertaken by the new chairman was that of revising both undergraduate and graduate curricula in order to take into account developments within this scientific field, to make use of the special qualifications of the fairly large staff, and to provide more systematic coverage of the subfields of psychology. The results of these efforts, which tended to unite the Department and build up a team spirit, proved so reasonable and successful as to attract the favorable notice of other departments, which in turn undertook the development of their own curricula along similar lines. In addition, he participated actively in the committees and councils of the University and won enduring respect as a scholar, teacher, and

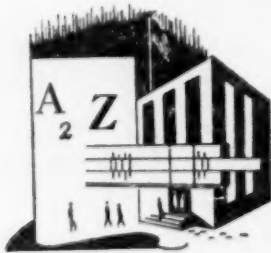
administrator. Thus, two great universities, Ohio State and Northwestern, came to regard him as a leader in science education.

Beginning in 1936 and continuing until his death, Valentine was the efficient and responsible treasurer of the American Psychological Association. In this period the membership increased from 587 members and 1,551 associates to a total considerably in excess of 4,000. From 1937 on, he was business manager of the Psychological Association's scientific journals. There were 5 of these publications when he began this service and 11 at the last. The auditors characteristically reported his accounts in good order; the Association at its annual business meetings, as a rule, readily accepted and approved the budgets he had worked out; and the editors of the several journals valued him as a responsible, cooperative, and congenial business and professional associate. His contributions to the growth and development of this scientific association and its business affairs were indeed very large. To a very wide group of colleagues he was known as "Val" and was valued as a warm and wise friend.

Finally came the opportunity, through the editorship of *Science*, to broaden the horizon and scope of his dearest ambition—the spread of scientific information and thought. Valentine was profoundly challenged and thrilled in being chosen as the successor-editor to James McKeen Cattell and the first editor after *Science* came under full control of the Association. He was ready to give his life with its every skill and ability to this opportunity. And this he did.

WALTER R. MILES

Yale University, New Haven, Connecticut



NEWS and Notes

Fifty societies will meet with 15 sections of the AAAS at its 114th meeting, to be held in Chicago, December 26-31, 1947. Synopses of section program plans reported by May 21 follow:

R. W. Brink, University of Minnesota, is developing the program of *Section A* (Mathematics) with the assistance of the Executive Committee of the Section, R. L. Moore, University of Texas, and T. R. Holcroft, Wells College. Four sessions have been planned for the morning and afternoon of December 29 and 30. In addition, a dinner session will be held on the evening of December 29. Arrangements have been made with J. R. Kline, of the American Mathematical Society, to count papers read before the meetings of Section A as having been read before the American Mathematical Society. Paul Dwyer, secretary, Institute of Mathematical Statistics, University of Michigan, has been asked to collaborate in organizing a joint session with the Institute. In general, the program will be devoted to contributed papers. E. P. Lane and R. E. Langer, recent vice-presidents and chairmen of Section A, have been asked to deliver their vice-presidential addresses at one of the sessions.

Section B (Physics) will meet jointly with the American Physical Society on December 29 and 30. "Astrophysics and Nuclear Physics" is the proposed title of one of the sessions, while the other will be in some field of biophysics. The meetings will probably be held on the campus of the University of Chicago. Joseph C. Boyce, New York University, secretary of Section B, is cooperating with Karl K. Darrow, Columbia University, secretary of the American Physical Society, in planning the joint symposia.

The program of *Section C* (Chemistry) is being organized by Ed. F. Degering, Purdue University, secretary of the Section, with the cooperation of the chairman, Farrington Daniels, University of Wisconsin. The sessions, running from December 26 through December 28, will

include a joint meeting with the Chicago Section of the American Chemical Society and a series of special symposia arranged by Dr. Daniels, Charles D. Hurd, Northwestern University, and Herbert C. Brown, Wayne University. The subjects will cover "Photosynthesis," "Industrial Processes," and "Mechanisms of Hydrocarbon Reactions." Other sessions will be devoted to general papers. A luncheon for chemists will be held on December 26.

Section D (Astronomy), under the direction of its secretary, C. C. Wylie, University of Iowa, will meet on December 26 and 27. In addition to general papers, a joint symposium has been planned with Section E (Geology and Geography) on the "Origin of the Solar System." Those cooperating with Dr. Wylie in the organization of the program include: D. B. McLaughlin, University of Michigan; George Van Biesbroeck, Yerkes Observatory; Harlow Shapley, Harvard Observatory; S. A. Mitchell, Leander McCormick Observatory; C. M. Huffer, secretary of the American Astronomical Society; and O. J. Lee, Northwestern University, who is acting as the local representative.

Section E (Geology and Geography) will meet on December 26 and 27. The December 26 sessions will center on a symposium entitled "Ground Water Geology and Engineering," organized by E. J. Schaefer, U. S. Geological Survey, Columbus, Ohio. J. Marvin Weller, University of Chicago, is arranging for a symposium on "Mississippian," to be presented on the morning of December 27, and in the afternoon Section E will meet jointly with Section D to discuss the "Origin of the Solar System." George W. White, secretary of Section E, is developing the program with the assistance of M. P. Billings, chairman.

As in past, the *Section F* (Zoology) and *Section G* (Botany) will meet jointly with allied societies. No independent programs have been proposed by either section.

Section H (Anthropology) will also meet on December 26 and 27. The afternoon session on December 26 will be devoted to general papers. On the morning of December 27 the Section will meet jointly with the Linguistic Society of America, through the cooperation of Carl Voegelin, editor of the *International Journal of American Linguists*; the afternoon session will continue the program initiated at Boston last year with a discussion on economic anthropology. This

session will be under the chairmanship of Melville Herskovits, Northwestern University. A dinner is planned for the evening of December 26. Marian W. Smith, Columbia University, is secretary of Section H, is in charge of the program.

Harold E. Burt, Ohio State University, secretary of *Section I* (Psychology), has organized 8 sessions. In a two-day program, contemplated for December 29 and 30, general papers will be grouped according to subject matter. On the evening of the 29th a joint session is planned for the presentation of addresses by Edna Heidebreder, Wellesley College, and W. A. Brownell, Duke University, vice-presidents of Sections I and Q, respectively. Dean A. Worcester, secretary of Section Q, is collaborating in the arrangements for this evening session.

The program plans of *Section K* (Social and Economic Sciences) and *Section L* (History and Philosophy of Science) have not crystallized sufficiently to be reported at this date.

Section M (Engineering) plans to meet December 29 and 30. The present program arrangements, under the direction of the Section secretary, Frank D. Carvin, Newark College of Engineering, call for a series of general technical papers on engineering and a symposium on "Limnological Aspects of Water Supply and Waste Disposal." Theodore A. Olson, School of Public Health, University of Minnesota, will serve as chairman of the symposium, which was organized in cooperation with G. L. Clark, Harvard University, secretary of the Limnological Society of America. The Chicago Technical Societies Council, represented by D. L. Tabern, Abbott Laboratories, is cooperating with Section M in sponsoring the program. J. T. Rettaliata, Illinois Institute of Technology, is chairman of the local committee in charge of meeting details.

Subsection Nm of the Section on Medical Sciences will present a four-session symposium on Antibiotics, December 29 and 30. Malcolm H. Soule, University of Michigan, secretary of the Section, is organizing the program.

Section O (Agriculture) will meet jointly with the American Society for Horticultural Science on December 30, both morning and afternoon. The secretary of Section O, E. E. DeTurk, University of Illinois, has announced that the program will deal in general with the problems of improving the breeding of horticultural crops.

Section Q (Education) will meet on December 29 and 30 for a discussion of the interrelationships of scientific method and social philosophy. D. A. Worcester, University of Nebraska, secretary of the Section, is organizing the panel of participants. On the evening of December 29 Section Q will join with Section I for the presentation of vice-presidential addresses.

About People

Henry Norris Russell, professor of astronomy, and director of the observatory, Princeton University, will retire July 1. **Lyman Spitzer, Jr.**, professor of astrophysics, Yale University, has been appointed director of the observatory, and **Martin Schwarzschild**, Columbia University, will become professor of astronomy.

Robert M. Muir, instructor in plant physiology at Pomona College, has been appointed assistant professor.

Bela K. Erdoss, associate professor and research associate, Department of Mechanical and Industrial Engineering, Lehigh University, has been appointed director of the new fluid dynamics program, being sponsored jointly by New York University and Stevens Institute of Technology, which opens in September. Dr. Erdoss will also become professor of hydrodynamics at the Institute.

John S. Lawrence, associate professor of medicine, and **Herman E. Pearse, Jr.**, associate professor of surgery, University of Rochester School of Medicine and Dentistry, have been assigned by the Atomic Energy Commission to a 3-month medical study in Japan, in connection with the casualties at Hiroshima and Nagasaki.

A. G. Christie, professor of mechanical engineering, Johns Hopkins University, and **Alfred Iddles**, vice-president and director, the Babcock & Wilcox Company, New York City, were the two official delegates representing the American Society of Mechanical Engineers at the centenary celebration of the British Institution of Mechanical Engineers, June 8-13.

J. A. Rosenkrantz, formerly chief of the Medical Section, Out-Patient Department, Veterans Hospital, Bronx, New York, has recently been appointed chief of the Out-Patient Department.

John R. Paine, formerly professor of surgery, University of Minnesota, has been appointed professor of surgery in the University of Buffalo Medical School and head of the Department of Surgery, Buffalo General Hospital.

Robert Galambos, of Emory University, has joined the staff of the Psycho-Acoustic Laboratory, Harvard University. Dr. Galambos is best known for his work on the ultrasonic 'radar' used by bats in flight and for his successful recording of nerve impulses in single fibers of the auditory nerve.

M. L. Jacobs, acting dean of the School of Pharmacy, University of North Carolina, since the death of J. Grover Beard last year, has been appointed dean by the University trustees.

T. D. Stewart, curator of Physical Anthropology, Smithsonian Institution, has recently returned to Washington from Guatemala, where he has been making a series of physical measurements of living Cakchiquel Indians in the highlands. The Cakchiquel, or "highland Maya," belong to the same racial and linguistic stock as the "lowland Maya," builders of the temple cities of Yucatan in pre-Columbian times. The measurements will be analyzed and compared with similar data on the Yucatan peoples. Dr. Stewart believes that the comparison will reveal notable differences between the Cakchiquel and present-day Yucatan Maya.

Karl Lehmann, professor of fine arts, and director, Archaeological Research Fund, New York University, is en route to Greece to salvage monuments which were uncovered by graduate students of the University before the war, and later desecrated during the Bulgarian occupation. Dr. Lehmann will also arrange for the continuation of the University's archaeological research and excavations on the island of Samothrace.

Arthur H. Compton, chancellor of Washington University, St. Louis, gave the 20th annual Steinmetz Memorial Lecture at Schenectady, New York, May 27, on "The Birth of Atomic Energy and Its Human Meaning." The annual lectures were inaugurated after the death of Charles P. Steinmetz, October 26, 1923, and each year a scientist who has made a notable contribution is selected as speaker.

Kenneth R. MacKenzie, associate professor of physics, University of British Columbia, has been appointed associate professor of physics, University of California, Los Angeles. During the war, Dr. MacKenzie served as research associate in the Radiation Laboratory, University of California, Berkeley.

James T. Barrett, professor of botany and plant pathology, University of California, Berkeley, was honored by colleagues and students June 4 at a dinner commemorating his 34 years on the California faculty, and the attainment of emeritus rank.

Tage U. H. Ellinger, head, Department of Zoology, Howard University, has been appointed chairman, Division of Natural Science, and professor of zoology, Regis College, Weston, Massachusetts.

Visitors To U. S.

V. Prabhaker Rao, entomologist of Bangalore, India, has been sent by his Government to the United States for a year to study our methods of combating the ravages of scale insects in fruit orchards, to investigate American methods of plant quarantine, and to study the classification of scale insects. Three months of this time is being spent at the Natural History Museum, Stanford University, which houses one of the largest collections of scale insects in the world. His classification studies are under the direction of Gordon F. Ferris, of the School of Biological Sciences. From Stanford Dr. Rao will proceed to the Citrus Experiment Station, University of California, and then to various border quarantine stations of the U. S. Department of Agriculture.

W. R. Piggott, of the British National Physical Laboratory, is now visiting the National Research Council of Canada at the invitation of its president, C. J. MacKenzie, and expects to spend some time in Washington, D. C., before his return to England. Mr. Piggott is personal assistant on radio matters to Sir Edward Appleton, permanent secretary of the Department of Scientific and Industrial Research, and is concerned principally with ionospheric work.

J. H. Seddon, of the Wingfield Morris Orthopaedic Hospital, Headington, Oxford, has been invited to the United States

to read papers at various medical meetings. He is particularly interested in U. S. work on peripheral nerve injuries and poliomyelitis.

D. W. Wright, of the Horticultural Research Station, Cambridge, is spending several months in the United States and Canada to observe work concerned with insect pests of vegetable crops, insecticides and spraying techniques, and biological control and population studies.

David S. Riceman, agrostologist, Division of Biochemistry and General Nutrition, Australian Council for Scientific and Industrial Research, is making an 8-month tour of U. S. universities to study mineral nutrition of plants.

E. L. Halliday, of the National Physics Laboratory of the South African Council for Scientific and Industrial Research, has recently come to the United States after a visit to England.

Colleges and Universities

The Western Reserve Pharmacy Foundation has launched a nation-wide campaign to raise \$528,850 for the purpose of constructing and equipping a new building for the School of Pharmacy, Western Reserve University. This step is the first in a long-range program to expand and improve Cleveland's Medical Center at the University and is directed more specifically toward reducing the critical shortage of trained pharmacists. An estimated 50 per cent more pharmacists will be trained each year.

The Foundation's Executive Committee includes: George Miller, president, Strong Cobb & Company, Inc., chairman; W. G. Leutner, president, Western Reserve University, honorary chairman; Edward Blythin, vice-president, Western Reserve University, treasurer; John C. Levy, Northern Ohio Druggists Association, secretary; William W. Hosler, Strong Cobb & Company, Inc.; Arthur P. Wyss, dean of the School of Pharmacy; and Wendell A. Falsgraf, University trustee.

The University of Chicago's Department of Astronomy will undergo a general reorganization and expansion, according to plans outlined to the Yerkes Observatory staff by Otto Struve, director of the Observatory, and chairman, Department of Astronomy. The plan,

which will be effective July 1, 1947, includes the personnel of both the Yerkes Observatory and the McDonald Observatory of the University of Texas. Some of the arrangements proposed by Dr. Struve are: that Gerard P. Kuiper be appointed director of the Yerkes and McDonald Observatories, with W. A. Hiltner continuing as assistant director; that a theoretical section be created under the supervision of S. Chandrasekhar, who will continue to reside at Williams Bay, Wisconsin; that W. W. Morgan be appointed managing editor of the *Astrophysical Journal*, and that the Chicago teaching section be revived under T. L. Page. Dr. Struve, who will guide the new policies and lay the broader plans for the Department, plans to reside at Williams Bay, and at Mount Locke, Texas.

The University of Pennsylvania Museum now houses sections of the oldest known legal code. Samuel N. Kramer, associate curator of the Babylonian Section, and Francis Steele, assistant, discovered the fragments while cataloguing inscriptional material which a University of Pennsylvania expedition to Southern Mesopotamia excavated from the ancient city of Nippur nearly 50 years ago. Written in cuneiform script in the Sumerian language by the Babylonian king, Lipit-Ishtar, its legal doctrines seem, in many instances, to have served as prototypes to the Hammurabi Code (about 1725 B. C.), which until now has been generally recognized as the world's oldest set of written by-laws. A preliminary paper on the contents of the Sumerian code was read by Dr. Steele on April 15 at the annual meeting of the American Oriental Society held in Washington, D. C.

Temple University Research Institute, Philadelphia, has been selected by the Sun Oil Company to complete a research project, begun by the Houdry Process Corporation laboratories, to investigate the causes of metabolic diseases using C^{13} as a tracer. Sidney Weinhouse, who directed the C^{13} project at the Houdry laboratories, will also head the Institute's program. Temple University Research Institute, directed by Gen. D. N. Hausman, was recently organized to further scientific knowledge at the university level, and to provide research facilities for industrial concerns, associations, and educational institutions sponsoring fundamental scientific research projects.

A new building for metallurgical research development will be erected at Iowa State College with funds allotted by the U. S. Atomic Energy Commission under a general research program. The four-story brick building and equipment will cost \$1,000,000. The program, which will be under the direction of F. H. Spedding, head of the Iowa State College Institute for Atomic Research, will continue and expand the work done at the College during the war on the development of processes which proved to be the most efficient methods for producing rare metals. The new building will provide facilities for investigation of all phases of metallurgy, as well as for fundamental research.

Summer Programs

The Institute of General Semantics has announced its 4th Annual Seminar and Workshop, to be conducted by Alfred Korzybski and co-workers at Lakeville, Connecticut, August 16-September 5. It is planned as a fundamental course in general semantics and non-Aristotelian methodology and is intended chiefly for those actively interested in the new methods of evaluation and their applications. The enrollment is limited to 50. Tuition for the three-week period is \$150. Further inquiries should be addressed to the Registrar, Institute of General Semantics, Lakeville, Connecticut.

The Naval Research Laboratory has a number of positions open for summer employment in the fields of physics, chemistry, mathematics, electronics, and mechanical and electrical engineering. Monthly salaries of these positions (grades SP-5 and -4) are approximately \$200 and \$185, respectively. Three and two years of appropriate college study or equivalent experience are required. A limited number of positions at higher grades, of particular interest to graduate students, are also open. Standard Form 57 (Civil Service Commission), required of all applicants, should be sent promptly to: Personnel Office, Naval Research Laboratory, Washington 20, D. C.

Meetings

The International Union of Chemistry has been informed by Director General Julian S. Huxley that UNESCO has provisionally allocated to the Union

for the year 1947 the sum of \$26,448, approximately \$20,000 of which is immediately available as a contribution toward meeting traveling expenses of members of the International Commissions planning to attend the 14th Conference of the Union in London, July 17-23, immediately following the Centenary Celebrations of the Chemical Society of London.

Celebrations of the Chemical Society will be under the presidency of C. N. Hinshelwood. The Conference of the Union will be under the presidency of Marston T. Bogert, professor emeritus of organic chemistry, Columbia University, who has held this position since his election in Rome in 1938. The 11th International Congress of Pure and Applied Chemistry, in association with which the Conference of the Union is to be held, will be headed by the Right Honorable the Viscount Leverhulme as president.

The International Union, a federation of 25-30 countries founded in 1919, has been rebuilt since the close of World War II. The coming Conference will be its first since 1938. Among its eight vice-presidents are Sir Robert Robinson, who recently received the Gold Medal of the Franklin Institute (Science, April 11, 1947), and Alexander Nesmeyanov, director of the Research Institute of Organic Chemistry, National Academy of Sciences, Moscow.

According to information received from Dr. Bogert, the American Chemical Society not long ago set aside a fund of \$25,000 for use in paying expenses in this country of foreign chemists and chemical engineers who could not engage in advanced study here without such aid. UNESCO is to designate the individuals who are to receive this support.

The American Mathematical Society will hold its First Annual Symposium in Applied Mathematics at Brown University, August 2-4, on the topic, "Nonlinear Problems in Mechanics of Continua." Major addresses will be delivered by the following: J. J. Stoker, New York University, "Surface Waves in Shallow Water"; F. D. Murnaghan, Johns Hopkins University, "The Foundations of the Theory of Elasticity"; K. O. Friedrichs, New York University, "The Edge Effect in Bending and Buckling With Large Deflections"; and Alexander Weinstein, Carnegie Institute of Technology, "Nonlinear Problems in the Theory of Fluid Motion With Free Boundaries."

A number of shorter research papers in the field will also be presented.

Further information may be obtained from Prof. William Prager, Brown University, Providence 12, Rhode Island.

A two-day Symposium on Sound will be held at the Salt Lake Tabernacle and the University of Utah, July 21-22, in connection with the Utah Centennial Celebration. The symposium, which will be open to the public, will include papers by: Harvey Fletcher and Mark B. Gardner, Bell Telephone Laboratories; S. S. Stevens, Harvard University; Vern O. Knudsen, University of California, Los Angeles; Ralph J. Christensen, U. S. Navy Electronics Laboratory, San Diego; Carl F. Eyring and Wayne B. Hales, Brigham Young University; Hillary W. St. Clair, U. S. Bureau of Mines; Alexander Schreiner, Salt Lake Tabernacle organist; and Carl J. Christensen and J. Irvin Swigart, University of Utah.

A Conference on Algebra will be held at the University of Michigan, July 25-28, under sponsorship of the Department of Mathematics. Seven sessions are planned which will feature papers by E. Artin, R. Brauer, S. Eilenberg, N. Jacobson, and S. MacLane. Additional papers on any aspect of algebra may still be submitted. Those wishing to present papers or obtain information about the Conference are invited to write to R. M. Thrall, 319 West Engineering Building, University of Michigan, Ann Arbor, Michigan.

Elections

The Wisconsin Academy of Sciences, Arts, and Letters, at its 77th annual meeting in Milwaukee, April 11-12, re-elected the following officers for 1947-48: L. E. Noland, University of Wisconsin, president; E. L. Bolender, Superior State Teachers College, vice-president in science; Don Anderson, Madison, vice-president in arts; Robert K. Richardson, Beloit College, vice-president in letters; Banner Bill Morgan, University of Wisconsin, secretary-treasurer; H. O. Teisberg, Historical Library, Madison, librarian; W. C. McKern, Milwaukee Public Museum, curator; and L. E. Noland, University of Wisconsin, representative on the Council of the AAAS. Hugo Rohde, Milwaukee, and Samuel Wadmond, Minneapolis,

were elected to life membership; Edwin B. Hart, Madison, and Katharine Lenroot, Washington, D. C., to honorary membership.

Robert Marshak, University of Rochester physicist formerly with the Los Alamos Laboratory, has been elected chairman of the Federation of American Scientists. The Washington office of the Federation, located at 1749 L Street, N. W., will continue its operations under William T. Higinbotham, executive secretary, and J. H. Rush, secretary-treasurer.

The New York Section of the American Association of Cereal Chemists, at a meeting on May 6, elected the following officers for the coming year: Henry H. Favor, R. T. Vanderbilt Company, chairman; Louis Bisno, Wagner Baking Corporation, Newark, New Jersey, vice-chairman; and Lawrence Atkins, Wallerstein Laboratories, secretary-treasurer.

The American Society for Clinical Investigation has named Eugene B. Ferris as editor-in-chief of the Society's *Journal of Clinical Investigation*. Dr. Ferris is associate professor of medicine in the University of Cincinnati College of Medicine. I. Arthur Mirsky and William B. Bean, associate professors of experimental medicine and medicine, respectively, at the University of Cincinnati, have been appointed associate editors. As of July 1 the editorial offices will be located in the Department of Internal Medicine, Cincinnati General Hospital.

The Medical Division, Army Chemical Center, Edgewood Arsenal, Maryland, has openings for toxicologists, experimental pathologists, and biophysicists, with salaries to range up to \$8,179.50 per annum. Inquiries should be addressed to Chief, Civilian Personnel Division, Edgewood Arsenal, Maryland.

Vincenza Porrini, Laboratorio D'igiene e Profilassi, Provincia di Firenze, Firenze (Florence), Italy, would greatly appreciate receiving unwanted or extra copies of the *Journal of Bacteriology* and other journals dealing with the laboratory sciences.

COMMENTS

by Readers

A paper by F. H. J. Figge (*Science*, March 28, p. 323) states some new and interesting results on the biological effects of cosmic radiation. The problem is a complex one, and possibly a physicist may properly call attention to a few of the pertinent physical considerations.

Most of the radiation reaching sea level consists of mesotrons (*Rev. mod. Phys.*, 1939, 11, 122-296), some of which are extremely penetrating. Indeed, small residual intensities have been detected as far down as instruments have been carried. Thus, it cannot be stated exactly what thickness of absorber is necessary to reduce the intensity to zero, for some slight intensity is found to be present under matter equivalent to 300 feet of lead. Presumably, about a mile underground the intensity will be so low as to be immeasurable with present apparatus. It is true, however, that a few feet of lead will materially reduce the radiation at sea level.

At higher altitudes the intensity is much greater, for the atmosphere constitutes a barrier equivalent to about 3 feet of lead. At an altitude between 18,000 and 19,000 feet, depending on local conditions, half the atmosphere is below the observer. At 30,000 feet he has only about a third remaining above him, and at 60,000, only a tenth. Indeed, at the latter elevation the total intensity of the radiation is about 100 times the sea level value, the exact amount depending on the latitude and on the surrounding material, for any biological specimen would require a considerable amount of surrounding matter to survive at 60,000 feet. The intensity at most of our cities at high altitudes in the West is 4 or 5 times the sea level value. At La Paz, Bolivia, where over 100,000 persons live at elevations of between 11,000 and 13,000 feet, and at the mines, such as Morococha, Peru, where the whole community lives at nearly 15,700 feet, the radiation may approximate 10 times the sea level value. The word "approximate" is essential, for the effect of surrounding material is considerable. High-altitude mines, where tunnels provide place for controls subject to much-reduced radia-

tion, would appear to be the ideal location for experiments on biological effects of the radiation. The intensity at each station would have to be determined, in order to enable the effect of surrounding matter to be assessed, but this measurement is fortunately not difficult.

Figge correctly cites the effect of lead plates in providing concentrated matter in which shower production is accentuated, so that below these plates there is more intensity than above, providing that by intensity one means a flux, or number of rays per square centimeter per second. If one means energy, then the statement is not true, for the total energy below the lead plate is less than that above by the amount of the energy absorbed in the lead. Thus, below the plate there are more particles, but each has a lower energy than those above. Biologists might find that the low-energy rays are more effective biologically than high-energy rays, for they are, on the average, more ionizing and lose more energy—and perhaps have more biological effect—per centimeter of path through the specimen.

The effect of surrounding matter is of the greatest importance. The astonishment on the face of a colleague who brought a cosmic-ray shower counter indoors and noted the considerable increase in number of showers indoors will always be a lesson in point. Inside a complex structure like a building, conditions are not uniform and in general not calculable, but again the intensity is readily measured.

Neutrons and protons are produced (S. A. Korff and E. T. Clarke. *Phys. Rev.*, 1942, 61, 422) by the cosmic radiation. The number, energy distribution, and subsequent history of these particles depends on the altitude and on surrounding matter. Possibly these particles may contribute to biological effects.

Finally, a word should be said about normal radioactive contamination. Often half the total ionization produced at sea level is produced by local contamination. Unfortunately, local radiation varies from place to place and from day to day, de-

pending on meteorology and other factors. Even if a biological specimen received no cosmic radiation, it is another problem to shield him from local rays. Local radiation can be reduced to a low value by a 10-cm. lead shield, but in the case of biological experiments this shielding is never complete, due to contamination of the specimen, his food, the container, and the air. If such radiation can penetrate a few centimeters of lead, it can certainly also produce some biological effects, and this would have to be taken into account. Again, the amount of local contamination is readily measured.

The results of the experiments reported by Figge are interesting and important and should be continued. Techniques exist whereby the intensity, either in flux or in energy, of the radiation can be measured, as can the amount of local contamination. Possibly this has already been done, but it was not so stated in the paper, and without this additional information it is hard to evaluate the results, or even to be certain that the results were attributable to cosmic rays and not to local contamination. (S. A. KORFF, *New York University*.)

Chromatographic studies showing the presence of α -aminobutyric acid and methionine sulfoxide in urine have been reported in a recent communication by C. E. Dent (*Science*, March 28, p. 335). The quantity of these metabolites excreted was increased after methionine administration; hence it was concluded that they were derived from methionine. The fact that methionine can be oxidized to the sulfoxide *in vivo* and, under certain conditions *in vitro*, leads him to question the validity of analytical procedures for the determination of methionine in urine by oxidation reactions (H_2O_2 , etc.).

As the author of such an analytical procedure (A. A. Albanese, J. E. Frankston, and V. Irby. *J. biol. Chem.*, 1944, 156, 293), the writer was naturally deeply concerned about this last suggestion and undertook to check his procedure in order to ascertain whether, in fact, aeration of the urine under these conditions would result in a loss of methionine by oxidation. It was found that prolonged aeration for 24 hours caused no appreciable reduction in the methionine content of urines or solutions of pure dl-methionine. The fear expressed by Dent would thus appear to be unwarranted. (ANTHONY A. ALBANESE, *New York University College of Medicine*.)

TECHNICAL PAPERS

B-Glucuronidase Activity of the Blood and Tissues of Obstetrical and Surgical Patients¹

WILLIAM H. FISHMAN

Departments of Surgery and Biochemistry,
University of Chicago

The enzyme β -glucuronidase hydrolyzes a large variety of conjugated glucuronides. Its function *in vivo* is believed to be the catalysis of glucuronide conjugation (1). In previous work, its relation to the metabolism of the estrogens has been demonstrated (4). In humans, glucuronides of the estrogens and their derivatives are excreted in the urine. The process of glucuron-

conjugation of the steroid hormones, its activity was studied in the blood cells and plasma in the various stages of human pregnancy. The following observations were made on the 30 women studied.²

As in most humans, there is a much greater concentration of the enzyme in the blood cells as compared with the plasma. However, the enzyme activity in the cells increases as pregnancy progresses and remains elevated for a short period after parturition. In the plasma, the enzyme shows peaks of increased activity and usually drops to normal levels after parturition. An example of the alterations in blood glucuronidase with pregnancy is shown in Fig. 1. While this study was in progress, it was noted that in one case there was a high plasma

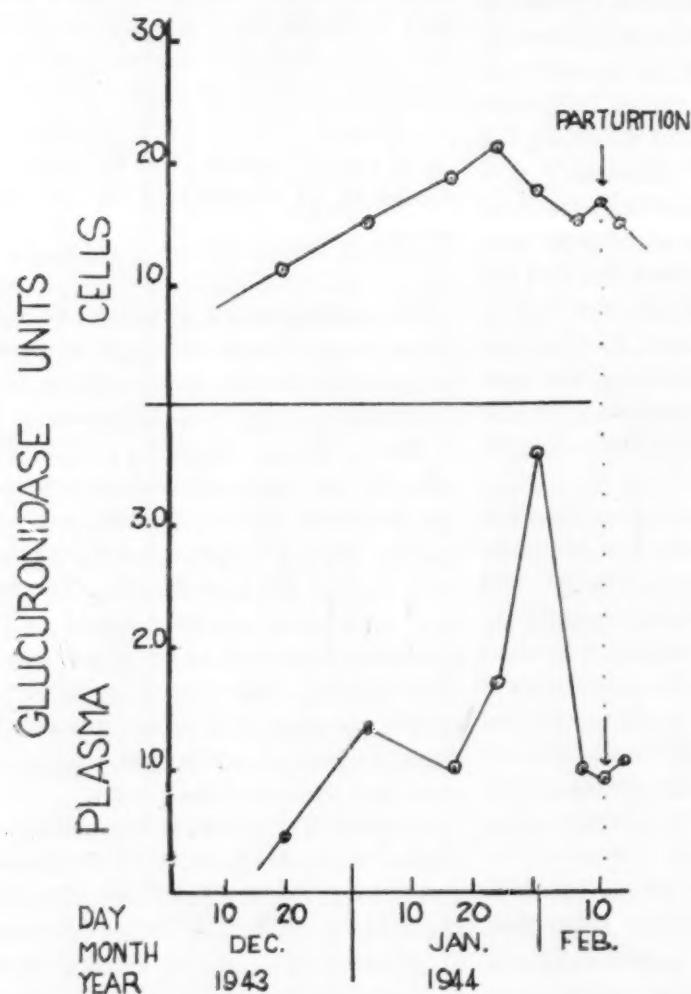


FIG. 1. Alterations in the β -glucuronidase activity of the blood of one patient as related to the last trimester of pregnancy and parturition. A glucuronidase unit here is defined as 1 mg. of glucuronic acid liberated from menthol glucuronide per hour at 38° per 100 cc. volume under standard conditions (1, 2).

ide formation should not be regarded necessarily as a detoxication mechanism but as one of "metabolic conjugation" (2).

Conjugated estrogens are excreted in large amounts during pregnancy. Since β -glucuronidase appears to be involved in the

¹ Aided by a grant from the Otho S. A. Sprague Memorial Institute.

TABLE 1*

Pa- tient	Pathological diagnosis		Units of glucuronidase activity			
	Lesion	Organ	Tissue		Blood	
			Tumor	Normal	Cells	Plasma
M.	Carcinoma	Breast	900	94	260	145
R.	"	"	1,930	62	579	118
K.	Fibroadenoma	"	393	325	563	150
K.	Carcinoma	Esophagus	1,510	750	1,098	278
B.	"	"	2,160	650	399	187
L.	"	Stomach	3,180	940	1,155	236
V.	"	Colon	900	1,930	200	266
O.	"	"	1,360	1,760	448	228
M.	"	"	5,250	2,490	633	91

* These data are taken from work in progress, which is being done in collaboration with A. J. Anyan. The full publication will appear at a later date.

† One unit is defined as 1 μ g. of phenolphthalein liberated from phenolphthalein mono β -glucuronide per hour at 38° from 1 gram of moist tissue or from a 100-cc. volume of cells or plasma under standard conditions (3,5).

glucuronidase associated with early toxemia. These preliminary observations suggest that the study of the blood glucuronidase in a large number of women may lead to a better understanding of the process of gestation and may also yield data of diagnostic value.

Since mammary tumors have been induced in animals by the prolonged administration of estrogens, it seemed desirable to study the β -glucuronidase activity of various tumor tissues obtained at operation. Wherever possible, the corresponding uninvolved tissue was also assayed. Plasma and blood cell glucuronidase were determined before operation. Some of the data are given in Table 1.

It is clear that in carcinoma of the breast the tumor contains from 10 to 20 times as much enzyme as the uninvolved

² The cooperation of Richard Forman is gratefully acknowledged. These patients were studied with the permission of the Department of Obstetrics and Gynecology, Bowman Gray School of Medicine, Winston-Salem, North Carolina.

breast tissue. No difference from normal was noted in the case of the benign fibroadenoma. In carcinoma of the gastrointestinal tract an elevated concentration of the enzyme is apparent in 4 of 6 patients.

From these few cases there seems to be no correlation of the blood glucuronidase with the incidence of cancer. However, one may speculate as to the reason for the relatively high glucuronidase activity in mammary tumors. Since glucuronidase activity has been found associated with the action of the estrogenic hormones (4), this suggests the accumulation of significant amounts of sex hormone in the mammary tumor. In cancer of the gastrointestinal tract, the question arises as to whether or not excessive amounts of estrogen may be present, in view of the elevated glucuronidase content.

References

1. FISHMAN, W. H. *J. biol. Chem.*, 1940, **136**, 229.
2. FISHMAN, W. H., in press.
3. FISHMAN, W. H. (Unpublished.)
4. FISHMAN, W. H., and FISHMAN, L. *J. biol. Chem.*, 1944, **152**, 487.
5. TALALAY, P., FISHMAN, W. H., and HUGGINS, C. *J. biol. Chem.*, 1946, **166**, 757.

Relabeling of the Cis and Trans Isomers of 1,3-Dimethylcyclohexane

FREDERICK D. ROSSINI and KENNETH S. PITZER
National Bureau of Standards, Washington, D. C.
and *University of California, Berkeley*

Evidence pointing to the necessity of relabeling the cis and trans isomers of 1,3-dimethylcyclohexane has been recently presented (6). The pertinent experimental facts may be summarized as follows: (a) The 1,3-dimethylcyclohexanes were synthesized by Skita and Schneck (7), who prepared a mixture of the cis and trans isomers by hydrogenating m-xylene, and who identified for the first time the lower-boiling and higher-boiling isomers as the trans and cis isomers, respectively, according to von Auwers' rule (8), and analogous to the isomers of 1,2-dimethylcyclohexane and 1,4-dimethylcyclohexane. (For these isomers, the lower-boiling one also has a lower refractive index and lower density.) (b) The low-temperature measurements of Oliver, Todd, and Huffman (6), coupled with values of the standard entropies of vaporization (2), yield experimental values for the standard entropy in the gaseous state at 25°C. such that, for the cis and trans isomers, the lower-boiling isomer has a standard entropy lower than that of the higher-boiling isomer by about 1–1.5 cal./deg. mole, in each of the three pairs, 1,2-dimethylcyclohexane, 1,3-dimethylcyclohexane, and 1,4-dimethylcyclohexane. (c) The energies of isomerization reported by Prosen, Johnson, and Rossini (6) for the gas state at 0° K are such that the three lower-boiling isomers have an energy content near 2 kcal./mole less than that of the corresponding higher-boiling isomer. (d) The data (3) giving the relative amounts of the cis and trans isomers formed in the hydrogenation (in the range 200°–250°C.) of each of the three xylenes show that the lower-boiling isomer is in each case the more abundant, the relative amounts being in accord, within the combined limits of uncertainty, with the values calculated (4) thermodynamically from the experimental entropies and heats of isomerization. The foregoing ex-

perimental facts are consistent in indicating a lower energy content, lower entropy, lower density, and lower refractive index for the lower-boiling isomer of the cis- and trans-1,2-, 1,3-, and 1,4-dimethylcyclohexanes.

It is also a matter of experimental fact that, among pairs of geometric isomers, the one possessing less steric hindrance has the lower energy content and usually has the lower boiling point, lower density, and lower refractive index. Various complex situations give exceptions to this rule. If the molecular configuration is such as to produce less steric hindrance in the trans isomer, the latter will normally have the lower boiling point, lower energy, etc., and the cis isomer will normally have the higher boiling point, higher energy, etc. This is the situation in the monoolefins (such as cis- and trans-2-butene) and in the cis- and trans-1,2-dimethylcyclopentanes, in which cases the trans isomer is the lower-boiling, etc.¹ In these cases, the name trans is synonymous with less steric hindrance.

But in the case of the cis and trans isomers of the 1,2-, and 1,3-, and the 1,4-dimethylcyclohexanes, Pitzer and Beckett (6) have shown that the trans configuration is not uniformly associated with the isomer of less steric hindrance. As has already been explained in detail by Pitzer, Beckett, and Spitzer (6), substantially all the molecules of cyclohexane are in the "chair" or symmetrically staggered configuration in which the successive CH₂ groups comprising the ring are alternately twisted up and down from a plane passing through the ring of carbon atoms. The result is that 6 of the hydrogen atoms lie in an equatorial belt extending out from the ring of carbon atoms, while the remaining hydrogen atoms are perpendicular to the plane through the ring of carbon atoms, three being above and called north polar, and three being below and called south polar. Of the 6 hydrogen atoms which are "cis" to one another, three may be described as north polar and three as equatorial. Of the two hydrogen atoms on each carbon atom, one is polar and one equatorial. If the 6 carbon atoms are all twisted through a single plane over to the opposite chair configuration, all hydrogen atoms originally polar become equatorial and vice versa. With this situation, there thus exists among the 1,2-, the 1,3-, and the 1,4-dimethylcyclohexanes two tautomeric forms for each isomer. Considering only the tautomeric form of lower energy in each case where the energies are different, the trans-1,2-, the cis-1,3-, and the trans-1,4-dimethylcyclohexanes each have both methyl groups equatorial, while the cis-1,2, the trans-1,3, and the cis-1,4-dimethylcyclohexanes each have one methyl group equatorial and one polar. Changing one methyl group from an equatorial to a polar position leads to an increase in the steric hindrance in the molecule and a consequent increase in its energy.

The statistical calculations (6) lead to values of the standard entropy lower for trans-1,2-, cis-1,3-, and trans-1,4-, respectively, than for cis-1,2-, trans-1,3-, and cis-1,4-dimethylcyclohexane. The analysis of the molecular structure also indicates that, in each pair (cis and trans), the isomers of lower energy should be trans-1,2-, cis-1,3-, and trans-1,4-dimethylcyclohexane. Furthermore, the calculated values of these differences agree quantitatively with the experimental

¹ See, however, G. Chiurdoglu (*Bull. Soc. Chim. Belg.*, 1944, **53**, 45), who has concluded, on the basis of rates of reaction, that in the 1,2-dimethylcyclopentanes, the cis isomer is the lower-boiling. We are not inclined to regard this type of evidence as at all conclusive.

values within experimental error. The statistical and molecular structure calculations, therefore, lead to the necessity of re-labeling the cis and trans isomers of 1,3-dimethylcyclohexane.

Since preparing this manuscript, we have belatedly come upon the work of Mousseron and Granger (5), which seems also to have been overlooked by others. Mousseron and Granger prepared the cis and trans isomers of 1,3-dimethylcyclohexane from appropriate optically active starting materials and found the optically active isomer, which must be trans (6), to be the higher-boiling member of the pair. This completely confirms the conclusion presented above.

For these reasons, a change has been made, as of March 31, 1947, in the naming of the cis and trans isomers of 1,3-dimethylcyclohexane in the tables of physical and thermodynamic properties and in the catalogues of spectrograms issued by the American Petroleum Institute Research Project 44. The change is such that the lower-boiling isomer, formerly labeled "trans," is now labeled "cis," and the higher-boiling isomer, formerly labeled "cis," is now labeled "trans."

The following notation will be used in the tables and catalogues of spectrograms listing these compounds:

cis-1,3-Dimethylcyclohexane.²

trans-1,3-Dimethylcyclohexane.³

In addition to the foregoing changes in connection with the work of the American Petroleum Institute Research Project 44, corresponding changes have been made in the work of the American Petroleum Institute Research Project 6 and in the cooperative program on standard samples of the National Bureau of Standards and the American Petroleum Institute.

All workers in other laboratories dealing with cis-1,3-dimethylcyclohexane or trans-1,3-dimethylcyclohexane are invited to relabel these two compounds in the manner described above. It is also recommended that, whenever either of the two names is written, one or more properties also be recorded for adequate identification apart from the name cis or trans. This latter step will completely eliminate any confusion which may arise from this relabeling.

References

1. AMERICAN PETROLEUM INSTITUTE RESEARCH PROJECT 44. *Selected properties of hydrocarbons*. Washington, D. C.: National Bureau of Standards, 1947. Table 7a.
2. AMERICAN PETROLEUM INSTITUTE RESEARCH PROJECT 44. *Selected properties of hydrocarbons*. Washington, D. C.: National Bureau of Standards, 1947. Table 7q.
3. BOORD, C. E., *et al.* American Petroleum Institute Research Project 45, Ohio State University. (Unpublished.)
4. KILPATRICK, J. E., WERNER, H. G., BECKETT, C. W., PITZER, K. S., and ROSSINI, F. D. *J. Res. nat. Bur. Stand.*, in press.
5. MOUSSERON, M., and GRANGER, R. *Bull. Soc. Chim.*, 1938, 5, 1618.
6. PITZER, K. S., and BECKETT, C. W. *J. Amer. chem. Soc.*, 1947, 69, 977; BECKETT, C. W., PITZER, K. S., and SPITZER, R. *J. Amer. chem. Soc.*, in press; OLIVER, G. D., TODD, S. S., and HUFFMAN, H. M. *J. Amer. chem. Soc.*, in press; PROSEN, E. J., JOHNSON, W. H., and ROSSINI, F. D. *J. Res. nat. Bur. Stand.*, in press.
7. SKITA, A., and SCHNECK, A. *Ber.*, 1922, 55B, 144.
8. VON AUWERS, K. *Lieb. Ann.*, 1920, 420, 92.

² This isomer, formerly labeled "trans," has the following properties (1): boiling point at 1 atm., 120.09°C.; refractive index, n_D at 25°C., 1.4206; density at 25°C., 0.7620 g/ml.

³ This isomer, formerly labeled "cis," has the following properties (1): boiling point at 1 atm., 124.45°C.; refractive index, n_D at 25°C., 1.4284; density at 25°C., 0.7806 g/ml.

The Dark Reductions of Photosynthesis¹

A. BENSON and M. CALVIN

Radiation Laboratory and Department of Chemistry,
University of California, Berkeley

Although green plants have been shown (4) to fix CO₂ in the dark, the conditions influencing that fixation and the compounds formed were unknown. We are investigating these variables.

The conditions of the experiments were as follows: A sample of actively growing algae was split into two parts (approximately 1 cc. algae/15 cc. suspension). One part (I) was kept in the dark, exposed to 4 per cent CO₂ in N₂ for about 8 hours. The other (II) was exposed to the light of a 150-watt tungsten lamp (.7 g.cal./cm.²/min.) for one hour, during which time it was kept free of CO₂ by constant flushing with N₂. The two samples were then evacuated, kept in the dark, and simultaneously exposed to the same gas containing C¹⁴O₂ in N₂ for a period of 5 minutes. At the end of this period, the algae were killed by an acetic acid-HCl mixture and the remaining active C¹⁴O₂ pumped off.

The total nonvolatile radiocarbon content of the two samples was then measured and its chemical distribution determined. The preliminary results are given in Table 1.

From these results alone, it is clear that the reduction of CO₂ to sugars and the intermediates in that reduction does not involve the primary photochemical step itself. This is further substantiated by the appearance of an appreciable fraction (up to 15 per cent) of the radiocarbon in the methylene groups of the succinic acid isolated from sample I of the table (3). It is

TABLE 1
DARK FIXATION OF CO₂ BY *Chlorella*

Pretreatment	I CO ₂ in the dark	II Light in the absence of CO ₂
Total (relative units).....	1	5.5
Succinic acid*.....	70%	6%
Fumaric acid.....	3%	1%
Malic acid.....	—	6%
Cationic substances† (not extractable by ether from pH 1—probably amino acids).....	15%	30%‡
Anionic substances† (not extractable by ether from pH 1).....	9%	10%
Neutral (sugars).....	<.1%	1.5%
Unidentified (extractable by ether from pH 6).....	2%	6%
Unidentified (extractable by ether from pH 1).....	—	25%

* The succinic acid was isolated without carrier and identified by extraction coefficient, equivalent weight, C and H analysis, melting point, and X-ray powder pattern.

† Absorbed by Duolite ion exchange resins C-3 and A-3, respectively.

‡ Largely alanine.

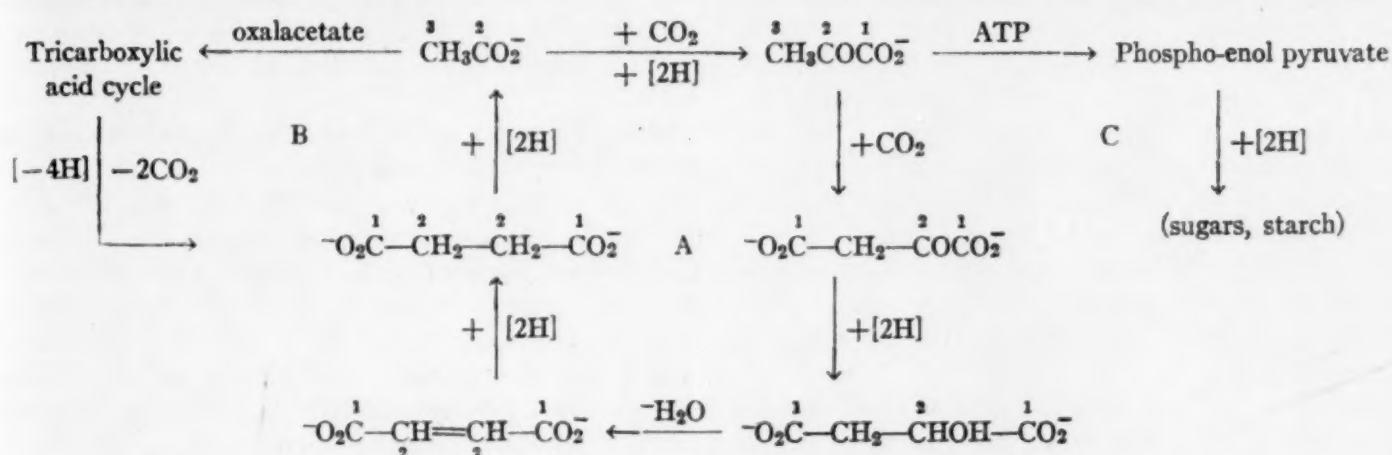
thus confirmed that the photochemical process establishes a reservoir (small, to be sure) of reducing power which can subsequently carry out all of the reduction steps necessary to bring CO₂ to sugar.

Using some of the reactions already established in animal tissue and bacteria (5), it is possible to account for the above

¹ This paper is based on work performed under Contract #W-7405-Eng-48 between the Atomic Energy Commission and the University of California.

results as well as the observed distribution of radiocarbon in sugar produced by a short photosynthesis (1).

photosynthesized radioactive sugars has a lower specific activity (per mg. C) than the sugar itself. If respiration in-



Starting with either acetate or pyruvate, the numbers over each carbon atom indicate which carbon atoms are labeled each time around cycle A. The reducing power (indicated as [2H]) is, of course, ultimately derived from the light reaction, and some of it might well be reduced coenzymes I or II. The high-energy phosphate required in these reductions is not explicitly shown in the chart. All or part of it could easily be derived from the combustion of part of the acetate through cycle B.

It should be mentioned that this scheme cannot be a simple reversal of the respiratory system of reactions, since CO₂ derived from respiration of barley leaves (2) containing freshly

involves some of the same intermediates as those shown in the chart, the respiratory system must be physically separated from the photosynthetic system.

References

1. ARONOFF, S., BARKER, H. A., and CALVIN, M. *J. biol. Chem.*, in press.
2. ARONOFF, S., BENSON, A., HASSID, W. Z., and CALVIN, M. *Science*, in press.
3. BENSON, A., BASSHAM, J. A., and CALVIN, M. (Unpublished.)
4. RUBEN, S., KAMEN, M. D., and HASSID, W. Z. *J. Amer. chem. Soc.*, 1939, 61, 661.
5. WOOD, H. G. *Physiol. Rev.*, 1946, 26, 198.

IN THE LABORATORY

The Oxalate Salt of P-Aminodimethylaniline, an Improved Reagent for the Oxidase Test

CHARLES M. CARPENTER, LEIF G. SUHRLAND, and MARTHA MORRISON

Department of Bacteriology, University of Rochester School of Medicine and Dentistry, Rochester, New York

The cultural method for the diagnosis of gonococcal infection, now a standard procedure (1) in most public health laboratories, utilizes the so-called "oxidase test" for rapidly distinguishing colonies of the *Neisseria* from non-oxidase-producing colonies of other genera. The oxidase reaction is considered to depend upon the reaction of an oxidative enzyme with an aromatic amine to produce a series of readily discernible color changes ranging from pink to black.

The dye component heretofore recommended for the oxidase test is the monohydrochloride salt of p-aminodimethylaniline. On standing, this agent deteriorates and becomes discolored, thereby reducing its solubility and the clarity of its aqueous solutions. The precipitate which forms interferes with the separation of oxidase-positive from oxidase-negative colonies in mixed cultures.

Because the oxalic acid salts of aromatic amines are, in general, more stable than the corresponding hydrochloride acid salts, the oxalate salt of p-aminodimethylaniline, [H₂NC₆H₄N(CH₃)₂]₂·(—COOH)₂,¹ was tested for its suitability in the oxidase reaction.

Observations were made on the rapidity with which the dry, crystalline oxalate salt deteriorated at temperatures ranging from 18° to 23° C. One per cent aqueous solutions of the monohydrochloride and of the oxalate salt were compared in the oxidase reaction on chocolate agar plates inoculated with cultures of *N. gonorrhoeae*, with mixed cultures of *N. gonorrhoeae*, streptococci, and diphtheroids, and with cervical and urethral exudates for evidence of gonococcal infection.

A comparative study of the stability of 1 per cent aqueous solutions of each compound was made at temperatures of from 18° to 23° C. Measurements of the oxidative changes in the two dye salts were made at 24, 48, and 72 hours after preparation of the solutions, using a Klett-Summerson colorimeter.

The toxicity of 1 per cent aqueous solutions of the two salts was tested on recently isolated strains of the gonococcus.

The dry, crystalline oxalate salt was more stable than the monohydrochloride salt. After 6 months storage at room tem-

¹ P-aminodimethylaniline oxalate was prepared and supplied by the Research Laboratories of the Eastman Kodak Company, Rochester, New York.

perature in amber bottles, no visible change was noted in the crystalline oxalate, whereas pronounced darkening occurred in the monohydrochloride salt. Aqueous solutions of the former could also be maintained for longer periods with less discoloration and precipitation. Furthermore, after standing 48 hours under the above conditions, less precipitation was noted in the aqueous solutions of the oxalate salt than in those prepared from the monohydrochloride salt. Comparative readings with a Klett-Summerson colorimeter showed that the solution of the oxalate salt needed to stand for 72 hours in order to give a reading equivalent to the 24-hour reading of the monohydrochloride solution, thus indicating that the rate of decomposition of the oxalate salt was approximately one-third that of the hydrochloride salt.

The toxicity of 1 per cent solutions of the two salts for the gonococcus was similar. Seventy-five per cent of the strains tested were viable after 5 minutes in either solution.

A slight disadvantage of the oxalate salt, however, was the relatively slower rate at which it went into solution in water at room temperature. This could be hastened by gentle heating.

Reference

1. CARPENTER, C. M. *Diagnostic procedures and reagents*. (2nd ed.) New York: American Public Health Association, 1945. P. 98.

Histochemical Method for the Detection of Phosphorylase in Plant Tissues¹

H. C. YIN and C. N. SUN

Botany Department, National Peking University, Peiping, China

Since its discovery in 1939 (1), phosphorylase has been found to occur in a number of plant species (2). It catalyzes the reversible reaction, starch + phosphate \rightleftharpoons glucose-1-phosphate (Cori ester). The importance of this enzyme in plant physiology is obvious. It represents the first synthesis, *in vitro*, of starch, the most important product of the plant kingdom. A histochemical method for its detection is highly desirable, since knowledge about its distribution and localization would be very helpful in studying the physiology of starch formation in plants.

The success of a histochemical method depends primarily on the formation of an insoluble, stainable reaction product specific to the enzyme. Obviously, neither glucose-1-phosphate nor the phosphate ion can be used in the present case because of their diffusibility, the difficulty of their detection, and complications due to other enzymatic reactions (e.g. phosphatase). Starch, however, answers all the requirements. The question resolves itself, therefore, into finding a plant tissue which is free, or can be made free, from starch.

In an investigation in one of our laboratories² it has been observed that soybean contains no detectable amount of starch until one to two days after germination. A histochemical method for phosphorylase can, therefore, be easily devised with this material.

Soybean (*Glycine Max* Merr.) soaked for 12 hours in water

¹ This work was started in Kunming, the wartime University site, and was continued in Peiping.

² Unpublished results of the Physiology Laboratory, Agriculture Institute, National Tsinghua University, Kunming.

was cut into free-hand sections 10–20 μ thick. The sections were incubated at 25°C. in a medium consisting of 1 per cent glucose-1-phosphate in a buffer saturated with toluol. Acetate buffer at pH 6 was generally used. Sections were taken out at frequent intervals and stained with iodine in potassium iodide.

Starch grains can be observed in some parts of the soybean section after 30–60 minutes of incubation, indicating the presence of phosphorylase.³ That the formation of starch is due to phosphorylase and not to other factors (e.g. phosphatase and amylase) is proved by the facts that (1) no starch can be found until more than 12 hours of incubation if glucose instead of glucose-1-phosphate is used in the medium; (2) no effect is produced by the presence in the medium of M/200 sodium fluoride, which completely inhibits the activity of phosphatase (3); and (3) boiled sections give no reaction.

Using the time of appearance of starch and its abundance as a measure of phosphorylase activity, it has been found that, in the soaked soybean, the most intense reaction is located in the rootcap,⁴ a less intense reaction is observed in the root tip and the lateral buds, still less in the young leaves, stem tip, and hypocotyl, and the least in the cotyledons.

Starch formation in intact germinating soybean has also been studied, and its relation to the distribution of phosphorylase will be given later in a more detailed report.

The present method is by no means limited to starch-free plant tissues such as soybeans. Most plant tissues can be deprived of starch by keeping them in darkness for a certain length of time. Geranium (*Pelargonium zonale* Ait.) leaves starved for two days in the dark, for example, show a strong phosphorylase reaction in the mesophyll cells after incubation with glucose-1-phosphate.

References

1. HANES, C. S. *Proc. roy. Soc.*, 1940, **B128**, 421–450; 1940, **129**, 147–208.
2. HANES, C. S. *Nature, Lond.*, 1940, **145**, 348.
3. YIN, H. C. *New Phytologist*, 1945, **44**, 191–195.

Use of Aerosol OT in Dissecting Salivary Glands of Mosquitoes Infected With Malaria

EDWARD S. JOSEPHSON, WILLIAM B. CULWELL,
and HELEN LOUISE TREMBLEY

Division of Physiology, National Institute of Health, Bethesda, Maryland

When mosquitoes are dissected in an aqueous medium such as physiological saline, extreme annoyance and difficulty are often experienced because of the tendency of the insects to float on top of the solution and the dissected parts to adhere to the dissecting needles. Since immersing the mosquitoes in ethyl alcohol does not always overcome this difficulty, another surface-tension reductant was sought which would insure thorough wetting of the mosquito and yet not damage the sporozoites which might be present in the salivary glands.

A method frequently used for dissections in this laboratory

³ A statement by J. B. Sumner (*Cornell Extension Bull.* **668**, 1945) that "soybeans lack phosphorylase" (p. 17), refers perhaps to dormant beans.

⁴ Phosphatase activity is strongest in rootcap of grains, according to Glick and Fischer (*Arch. Biochem.*, 1946, **11**, 65–79).

consists of anesthetizing the mosquitoes, removing them to a Syracuse watch glass, placing a drop of 70 per cent ethyl alcohol on each insect, filling the watch glass with distilled water, and finally transferring each mosquito to a drop of physiological saline on a microscope slide for dissection.

The method followed in testing new agents was to immerse the anesthetized mosquitoes in the test solutions and then transfer them, in a drop of the same material, to a slide for dissection.

Preliminary trials were made, employing in turn (1) isoamyl alcohol, (2) capryl alcohol, (3) ethyl acetate, and (4) Aerosol OT (dioctyl sodium sulfosuccinate). The first three compounds were discarded because, in the concentrations used, their immiscibility with water made detection of sporozoites difficult. Aerosol OT, however, seemed to possess the desired properties and was, therefore, examined further.

A 1:100 stock solution of Aerosol OT was made by adding 100 ml. of distilled water to 1 gram of Aerosol OT and allowing it to stand overnight at room temperature. Working solutions were made from this stock by subsequent dilution with physiological saline (0.85 per cent NaCl solution).

As a result of a series of observations using both *Aedes aegypti* infected with *Plasmodium gallinaceum* and *Anopheles quadrimaculatus* infected with *P. vivax*, a 1:60 dilution with physiological saline of the 1:100 aqueous stock Aerosol OT solution (final dilution of Aerosol OT, 1:6,000) was ultimately found to be optimal.

In order to determine whether the 1:6,000 Aerosol OT solution has a deleterious effect on the sporozoites, the viability of sporozoites from mosquitoes wet and dissected in this solution was compared with that of sporozoites from mosquitoes wet in 70 per cent ethyl alcohol and dissected in saline. *A. aegypti* infected with *P. gallinaceum* were used. Twenty chicks, about one week old, were divided into 4 groups of 5 each. Each chick was injected subcutaneously with the infected salivary glands from one mosquito. The first group of 5 chicks (A) received the infected glands immediately after the glands were dissected in Aerosol OT. The second group (B) was inoculated with infected glands which had been dissected in Aerosol OT and allowed to remain in that medium at room temperature for 15 minutes. Two control groups (C and D) were inoculated with infected glands dissected in physiological saline. Chicks in group C received the glands immediately after dissection, while those in group D were inoculated with the glands which had remained in saline at room temperature for 15 minutes.

All of the chicks in group A showed infection on the 11th day; of those in group B, three showed infection on the 11th day, one on the 13th, and one on the 18th. All of the chicks in the control groups, C and D, with the exception of one which died early in the experiment, exhibited parasites on the 11th day.

In a similar experiment using a 1:4,000 dilution of Aerosol OT, the infections in the groups dissected in Aerosol OT were delayed, only three chicks in groups A and B exhibiting parasitemia by the 36th day. All of the chicks in the control groups showed infection by the 9th day.

These experiments establish the fact that a 1:6,000 dilution of Aerosol OT is a good wetting agent for mosquitoes; the insects can be dissected easily, and if sporozoites are present in the salivary glands, they are readily detected. However, it

appears to have a deleterious effect on sporozoites of *P. gallinaceum*, and should be used with caution when the sporozoites of this or other species are to be used for producing infections.

A Quick Method for Filling Curved Glass Apparatus With Liquids

WILLIAM N. CAMPBELL and ANDREW SOKALCHUK

Departments of Pathology and Physiology,
Temple University School of Medicine, Philadelphia

The usual technique of filling certain types of glass apparatus with a liquid requires the tedious and time-consuming procedure of immersing the apparatus first in hot water and then in cold, the apparatus being connected to the liquid when it is placed in the cold water. This procedure must be repeated many times, and much difficulty is usually experienced in disposing of the last air bubble.

A simple and quick way to accomplish the task is to thread two small, flexible plastic tubes through the curved glass

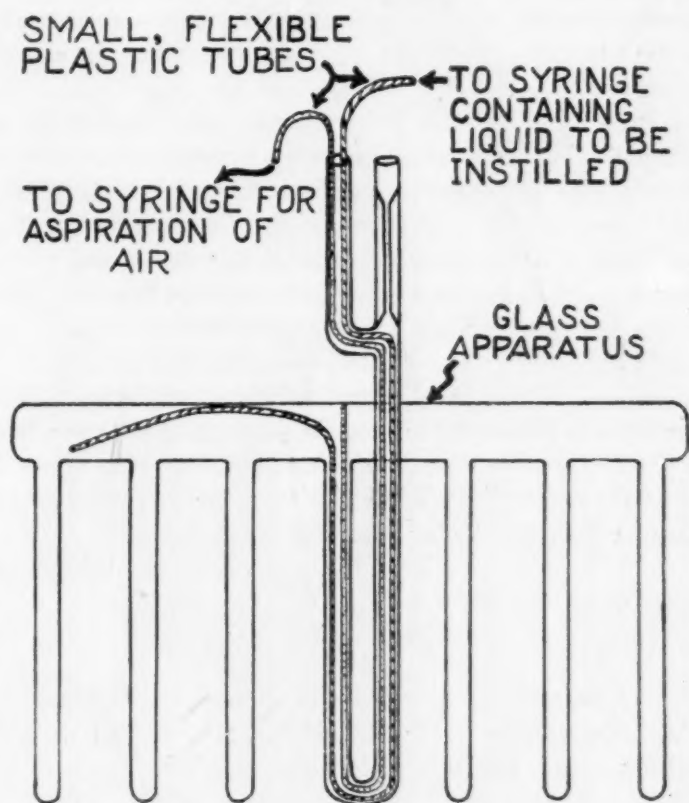


FIG. 1

tubing to the top of the apparatus (the plastic being non-soluble in the liquid used). The tubing can be passed around bends more easily by repeated short thrusts associated with a twisting motion than by steady pressure. Each plastic tube is then connected to a needle of appropriate size, attached to a large syringe. One syringe is used for instillation of the liquid, and another for the concomitant aspiration of air. After filling the glass apparatus, the plastic tubes are carefully removed.

Using polyethylene tubing furnished by Suprenant Electrical Insulation Company, a glass apparatus designed for use as a thermoregulator was completely filled with toluene in a period of 10 minutes (Fig. 1).

The described technique is of especial value when the layering of solutions is necessary or volatile liquids are being used.

Book Reviews

Elsevier's encyclopaedia of organic chemistry. Vol. XIV: *Tetracyclic and higher-cyclic compounds*; Series III: *Carboisocyclic condensed compounds*. E. Josephy and F. Radt. (Eds.) New York-Amsterdam: Elsevier Publishing Co., 1940. Pp. xx + 736. \$60.00; to subscribers of Series III, \$52.50; to subscribers of complete work, \$45.00.

This new *Encyclopaedia of organic chemistry*, of which Volume XIV is the first to appear, is to be a complete survey of all organic compounds together with their chemical, physical, and physiological properties. It is to be printed in English. Since this series of volumes contemplates the coverage of the literature in a manner somewhat similar to Beilstein, a comparison is pertinent.

The physical and chemical data under any individual compound are less extensive, and the arrangement of references, though space conserving, is less convenient than in Beilstein. Abstract journals have sometimes served as source material for the Elsevier publication; the original literature always, in the case of Beilstein.

Volume XIV is well printed and more readable than Beilstein. The inclusion of numerous structural formulas is advantageous, and the presence of subject and formula indexes will be very helpful. The assembly of the work on tetracyclic and higher-cyclic compounds includes the sterols and many other types of molecules not now appearing in Beilstein. This publication deserves a place in any good chemical library.

Whether Elsevier has adopted a classification which will be preferable to that of Beilstein and whether it will be possible to complete this series by 1962 and then keep it up to date within 10 years remains to be determined. Organic chemists will eventually decide the relative merits of the two publications based on their day-to-day experience with them.

ROGER ADAMS

University of Illinois, Urbana

The chemistry of commercial plastics. Reginald L. Wakeman. New York: Reinhold, 1947. Pp. xii + 836. (Illustrated.) \$10.00.

It is some 12 years since the well-known treatise, *Chemistry of synthetic resins*, was published by Ellis. In the preface to the present book, the author states that he makes "no pretense of being encyclopedic in the sense of Ellis" and that "little or no consideration has been given to innumerable journal articles and patents which are not rather directly reflected in current commercial operations." However, he does "attempt to be selective to information particularly pertinent to industrial practice."

In these words the author states both the strength and weakness of the text—strength, because the selection is a natural one, based on sound current commercial considerations; weakness, because the text is dated with no hint that changes have already taken place and that pertinent information is now available in the patent literature. As the writer states in the conclusion, "Daily a new resin is born, a striking application

created or a novel process of fabrication perfected." Since any of these announcements are usually first printed in the Official Gazette of the U. S. Patent Office, it is obvious that such recent products and developments are not mentioned. Moreover, a better acquaintance with the patent literature would have allowed much better "guesses" as to the chemical constitution of many plastic compositions.

The book is divided into 26 chapters, the mean chapter length being approximately 30.5 pages. It is perhaps significant that the subject treated most closely to the mean length is that on the new developments in "Contact Resins." The longest chapter (88 pp.) covers "Vinyl Resins," whereas the shortest disposes of the "Aryl Sulfonamide-Formaldehyde Resins" (3 pp.). Other longer chapters include: "The Mechanical Manipulation of Plastics," "Phenolic Plastics," "Alkyds and Allied Resinous Esters," "Polystyrene," "Acrylic Resins," "Natural and Synthetic Elastomers," and "Cellulose Plastics." Although the writer leans heavily on technical data supplied by the sales divisions of various plastic manufacturers, his judgment is not warped by this information, nor is the reader swamped with details on various competitive products. Pertinent references are appended to each chapter. These references, as indicated, are notably free of patent citations, but the general selection of technical information and trade reports is noteworthy. The treatment is comprehensive, from a description of the coating of Noah's ark to a one-page section on miscellaneous German wartime developments.

In any text of this type a good index is almost mandatory. This book contains complete trade names, author, and subject indexes, comprising 3½, 6, and 30 pages, respectively.

EDWARD L. KROPA

American Cyanamid Company,
Stamford, Connecticut

Scientific Book Register

CULVER, CHARLES A. *Musical acoustics*. Philadelphia-Toronto: Blakiston, 1947. Pp. xiv + 215. (Illustrated.) \$3.00.

MORTON, C. V. *The American species of Hymenophyllum section Sphaerocionium*. (Contributions from the U. S. National Herbarium, Vol. 29, Part 3.) Washington, D. C.: Smithsonian Institution, 1947. Pp. viii + 62. \$3.00.

NATHAN, DAVID S., and HELMER, OLAF. *Analytic geometry*. New York: Prentice-Hall, 1947. Pp. x + 402. \$3.50.

SCHELL, IRVING I. *Dynamic persistence and its applications to long-range foreshadowing*. (Harvard Meteorological Studies, No. 8.) Cambridge, Mass.: Harvard Univ. Press, 1947. Pp. 80. (Illustrated.)

THOMPSON, HENRY DEWEY. *Fundamentals of earth science*. New York-London: D. Appleton-Century, 1947. Pp. xiii + 461. (Illustrated.) \$3.75.